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ABSTRACT

Presented are summaries of various activities within a seminar organized by Unesco at Cali, Colombie, to examine scientific aspects of the mangrove ecosystem and the human impact upon it. Specifically, the aims of the seminar were: (1) to review studies on mangroves being carried out in Latin America and the Caribbean; (2) to foster contacts between researchers; (3) to promote awareness of the importance of the mangrove ecosystem; (4) to establish guidelines for a regional project for multi-purpose research and human resources training. Summaries of decisions and discussions in each of these areas are provided. Tables provide an example of a suggested curriculum for the training of systems ecologists. Suggestions for research on each region or type of mangrove are given. Conclusions and recommendations of the conference participants strongly support cooperative efforts of Latin American countries possessing mangrove areas. (CS)

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Unesco Reports in Marine Science 9

The Mangrove Ecosystem: Scientific Aspects and Human Impact

Report of the seminar organized by Unesco at Cali, Colombie

27 November - 1 December 1978

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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PREFACE

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1. INTRODUCTION

Mangrove ecosystems are found in the tropical regions of Africa, America, Asia and Oceania. They are in fact tropical forests on the seaboard, usually in places where large deltas have been created by rivers emptying into the sea and where the substratum is composed of accumulated deposits of mud and there are constant variations in salinity. The main abiotic factors are the continual mixing of water from the landmass and the sea, with the consequent variation in salinity that this occasions; the accumulation of mud on the river banks and along the costal belt, which makes it easier for certain tree species to put down their pneumatophore-type roots; heavy rainfall; high temperatures with scarcely any variation; and a high degree of atmospheric humidity. All these conditions have made it possible for many animal populations which have acquired significant economic value to establish their habitat there (peneides, callinectes, mugilidae, congridae, centropomidae, scorpaenidae, arcidae, donacidae, ostreidae, etc.). These species seek out the mangrove areas because of the abundant food supply and because they can find pockets of still water where they can lay their eggs and their larvae can breed.

In addition to being fished commercially and for subsistence consumption, many of these species are suitable for fish-farming, so that aquaculture can be undertaken on a large scale, thus improving the food supply of the inhabitants.

Owing to the tropical nature of mangroves, the incidence of a variety of diseases and the high temperatures, they have come to be regarded as insalubrious areas that need not be conserved. Many mangrove regions have been jeopardized by the felling of trees for use as firewood and building materials or the stripping of the bark to produce tannin, and indeed by attempts to clear insalubrious areas and develop them for tourist purposes. As a result, the animal species of direct value to man are also in danger of extinction.

In Latin America, the mangrove regions extend from the Tropic of Cancer to latitude 3°30' S on the Pacific seaboard, where they are halted by the marine currents off Peru, and approximately from latitude 30° N to latitude 25° S (Florianopolis, Brazil) on the Atlantic coast. The danger represented by the human impact is, in quantitative terms, rather less marked on these coasts than in other continents, but the large-scale port works and reclamation schemes for agricultural and tourist purposes being undertaken in some countries, not to mention the slower process of timber depletion already mentioned, give cause for concern.

Having regard to the facts of the situation outlined above, Unesco, through its Division of Marine Sciences and with the backing of its Regional Office for Science and Technology in Montevideo, decided to organize a "Latin American Seminar on Scientific Aspects of the Mangrove Environment in Latin America" and the Human Impact on it. The seminar was convened in pursuance of resolution 2.181 adopted by the Unesco General Conference at its nineteenth session, held in Nairobi, by which the Director-General was authorized to continue to implement the programme aimed at promoting advancement of the marine sciences, special attention being given to the problems of coastal areas.

At the invitation of the Colombian Government, through its Ministry of Education and with the direct support of Colciencias (The "Francisco José de Caldas" Colombian Fund for Scientific Research and Special Projects) and the Universidad del Valle, the seminar was held in Cali from 27 November to 1 December 1978. Dr. Ricardo Rojas Beltrán, of the above-mentioned university, was in charge of the local organization of the seminar.

The following themes were discussed:

I. Inventory of mangrove areas

II. Structure and dynamics of the mangrove ecosystem

III. Natural and artificial stresses on the mangrove environment

IV. Population, demography and health

V. Resource utilization and economy

VI. Perception of the mangrove environment and legislation

VII. Rehabilitation, management and conservation

VIII. Basic guidelines for the implementation of a pilot project for training and research on the mangrove ecosystem in Latin America

Specialists with broad experience of the relevant subject areas were invited to lead the discussions, and presented individual papers on their specialized field.

In addition, 37 research workers from 15 countries, chiefly from Latin America and the Caribbean (Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, French Guiana, Grand Cayman, Mexico, New Zealand, Peru, Puerto Rico, Trinidad and Tobago, United States of America and Venezuela), presented their research findings, in accordance with the programme reproduced in Annex I, while 44 scientists and students, mainly Colombian nationals, were present as observers.

The seminar started with a preparatory meeting, which designated Dr. Gilberto Cintrón as Scientific Co-ordinator and Dr. Ricardo Rojas Beltrán as General Rapporteur, and also designated the rapporteurs for the various themes. A special commission was set up under the chairmanship of Dr. Ariel Lugo, to examine the basic guidelines for a co-operative project for research and personnel training. This commission was composed of the following research workers: P. Bacon, J.F. Bouchard, O. González, L.I. Gutiérrez, R. Horna, M. Kutner, R. Pannier, C. Quiroz, R. Rojas and C. Villalobos. Dr. Manuel Vegas Vélez, marine sciences specialist of the Unesco Regional Office for Science and Technology for Latin America and the Caribbean (ROSTLAC, Montevideo), was in charge of the technical secretariat.

The aims of the seminar, as outlined at the preparatory meeting by the Unesco delegate, can be summarized as follows:

(a) to review studies on mangroves being carried out in Latin America and the Caribbean;

(b) to foster contacts between research workers from the countries represented at the seminar;

(c) to promote awareness of the importance of mangroves from the ecological, cultural, health and socio-economic points of view;

(d) to lay down guidelines for a regional project for multi-purpose research and human resources training.

The opening meeting took place in the presence of the Mayor of Cali, Dr. Rodrigo Escobar Navia, and of the Director of Research of the Universidad del Valle, Dr. Jorge Orlando Melo, both of whom delivered addresses, as did Dr. Ricardo Rojas Beltrán, in his capacity as national co-ordinator of the seminar.

The opening meeting and the working meetings were held in an airconditioned room at the Universidad del Valle, which was also fitted out with simultaneous interpretation and audio-visual facilities. Special mention should be made of the care taken by the Colombian authorities, and particularly by the national co-ordinator, to maintain consistently high standards of local organization, enable national research workers to attend the meetings, and see to the needs of all the visitors.

At the closing meeting, after the conclusions and recommendations had been approved, the technical secretary, speaking on behalf of Unesco, thanked the experts for attending the seminar and for the valuable teamwork they had accomplished and the Universidad del Valle for the facilities it had provided. This Report gives a brief account of the themes discussed, summaries of the papers presented, and the conclusions and recommendations adopted. Thanks are due to Dr. Cintrón and Dr. Rojas for their assistance in preparing the Report.

2. SUMMARY OF THE THEMES DISCUSSED

Theme I: Inventory of mangrove areas

Leader of discussion: Valentine J. Chapman
Raporteur: F. Serrano

G. Cintrón and C. Goenaga: "Observaciones sobre el desarrollo del manglar en costas áridas" (Observations on the development of mangrove areas on arid coasts)

F. Serrano: "Uso de compartimientos sistemáticos en el estudio de manglares como ecosistemas" (Use of systematic compartments in the study of mangroves as ecosystems)

J. Palacio: "Variación de los invertebrados de la raíz de mangle (Rhizophora mangle) en la Ciénaga Grande de Santa Marta" (Variation of invertebrates in mangrove root formations (Rhizophora mangle) in the "Ciénaga Grande de Santa Marta" swamp).

N. Bastidas de Pascuas: "Características fitosociológicas de los manglares en el Parque Natural Tayrona" (Phytosociological characteristics of the mangroves in the Tayrona Natural Park).

J.H. Torres: "Contribución al conocimiento de las plantas tanantes y colorantes que proliferan en Colombia" (Contribution to the knowledge of tannin and dye plants commonly encountered in Colombia).

Dr. Chapman introduced the theme by discussing a number of features of mangrove vegetation. He said that two main biogeographical regions - the Old World and the New World - could be identified as far as mangroves were concerned. A greater variety of species existed in the Indian and Pacific Ocean regions, which suggested that mangroves probably originated there. In all, 53 species were considered as being covered by the term "mangrove" and, of these, 42 were to be found in the Indian and Pacific Ocean region. Only 7 species were found in the North American Pacific region, and 10 on the Atlantic seaboard of North America. Seven species had been described which were found on the west coast of Africa.

He said that mangrove species could tolerate salt water, but were not necessarily halophytic. Sonneratia, for example, had been found at elevations of more than 170 metres above sea-level, and Rhizophora was occasionally found growing in freshwater environments.

With regard to the substratum, he said that he had established that Laguncularia was not confined to boggy soil, but was frequently found on sandy substrata such as beaches and reefs.

Another aspect discussed was the distribution of mangrove species, whose present-day distribution Dr. Chapman ascribed to changes in the orientation of the continents as a result of continental drift.

He concluded by calling attention to the papers describing different mangrove areas published in New Zealand, and suggested that similar publications should be prepared in Latin America.

Theme II: Structure and dynamics of the mangrove ecosystem

Leader of discussion: Rosario de Pannier
Rapporteur: C. Flores

M.B.B. Kunter: "Estudios de plancton en una región de mangle: Cananéia" (Plankton studies in a mangrove area: Cananeia).

O. González R.: "Tabla de volúmenes para manglares" (Chart of mangrove volumes).

J.P. Lescure: "The architecture of mangrove forests in French Guiana".

A.E. Oliveira: "Distribution of estuarine fishes in north-east Brazil, in relation to salinity".

C. Villalobos: "Recursos bióticos en lagunas costeras, manglares y áreas adyacentes de América Latina" (Biotic resources in coastal lagoons, mangroves and adjacent areas in Latin America).

M. Espinosa: "La fauna sésil intermareal del manglar relacionada con algunos parámetros ambientales en la Laguna de Términos, Campeche" (Intertidal sessile fauna of mangroves in relation to a number of environmental parameters in the Laguna de Términos, Campeche).

F. Lachica: "Diversidad espacial y temporal de la bentocenosis del estuario del Río Coatzacoalcos, Veracruz" (Spatial and temporal diversity of benthocenosis in the estuary of the River Coatzocoalcos, Veracruz).

C. Flores: "El manglar como refugio y sustrato de componentes faunísticos" (Mangroves as a haven and substratum for faunistic components).

P.N. Coutinho: "Los manglares de la planicie costera de Recife" (The mangroves of the coastal plain of Recife).

J.R. Cantera, R. Contreras, F. Borrero, E. Duttkus, F. Zapata: "Historia natural del gasterópodo del mangle, Thais kiosquiformis Duclos, 1832, en la costa del Pacífico Colombiano" (The natural history of the mangrove gasteropod Thais kiosquiformis Duclos, 1832, on the Pacific coast of Colombia).

R. Horna: "Relación suelo-mangle (Rhizophora mangle, Conocarpus erectus, Laguncularia racemosa, Avicennia nitida)" (The soil-mangrove relationship (Rhizophora mangle, Conocarpus erectus, Laguncularia racemosa, Avicennia nitida).

J.M. de Morais "Intertidal flat sedimentation of the Bacanga River Estuary" (presented by P.N. Coutinho).

María E. Pérez and Carlos H. Victoria:	"Aspectos de la comunidad de invertebrados de las raíces sumergidad del mangle rojo en la Bahía de Cartagena" (Aspects of the invertebrate community living among the submerged roots of the red mangrove in Cartagena Bay).
H. Quiroz and G. Vernette:	"Los foraminíferos bentónicos en áreas de manglar, su relación con el ecosistema (Tierra Bomba - Cartogena)" (Benthonic foraminifera in mangrove areas and their relationship to the ecosystem (Tierra Bomba - Cartagena)).

This working meeting opened with an address by Mrs. Rosario de Pannier, who stressed the importance of the physio-ecological approach to mangrove studies. In her view, the scientific management of mangrove areas required a knowledge of the way in which the vegetation responded to environmental factors.

Aspects calling for evaluation included the nutritional requirements of the species composing the mangrove system and their response to the salt level in the soil. She cited the example of high soil salinity, which made the supply of water a costly item in energy terms, owing to the need to produce organic solutes in order to maintain the osmotic balance.

She said that very few studies of nutritional requirements had been carried out, although it had been shown that Rhizophora could use nitrogen in the form of ammonia. It was in that form, in fact, that the element chiefly occurred in mangroves, but adaptation to the use of ammonia in this way did not preclude the use of nitrates. The availability of those elements clearly determined the degree of structuration and productivity of the vegetation. Moreover, mangrove vegetation helped maintain a special micro-climate in the forest and soil, as a result of the dense crown which it formed.

She said that timber felling caused drastic changes in the level of luminosity, temperature and other factors, and that these had an adverse effect on soil properties. Areas which had been subject to felling were frequently invaded by the fern Acrostichum aureum, which was usually found at the edges of mangrove areas, since its spores needed light to develop. The colonization of the ground by this fern prevented the natural repopulation of the area by mangroves.

Theme III: Natural and artificial stresses on the mangrove environment

Leader of discussion:	Samuel C. Snedaker
Rapporteur:	D. Mizrachi
L.B. Cavalcanti, P.A. Coelho, E.E. Leca, J.A.C. Luna, S.J. de Macedo and M.N. Paranaguá (presented by L.B. Cavalcanti):	"Condiciones ecológicas del área de Suape (Pernambuco-Brasil)" (Ecological conditions in the Suape area (Pernambuco, Brazil)).
D. Mizrachi and F. and R. Pannier:	"Infección de Lorantáceas como agentes disturbadores del equilibrio del manglar y estrategias para el establecimiento de Conocarpus erectus" (Lorantaceae as agents disturbing the equilibrium of mangrove areas, and strategies for the introduction of Conocarpus erectus).

The day's discussions began with a statement by the leader of the discussion, in which he first gave a brief account of the work being carried out by the SCOR/Unesco

working Group(1) and of the function performed by the group in respect of the elaboration of mangrove research methods and the identification of the problems arising in mangrove ecosystems. He went on to emphasize that both basic and applied research should be intensified, with the aim of describing the structure and functioning of mangroves as systems. In addition, the natural and man-induced stresses exerted on mangrove areas should be evaluated. A better balance was needed between conventional studies (basic and applied) and holistic studies at the level of the systems themselves and of interactions between systems. At the present time, less than 10% of the scientific research being conducted in that field was of the latter type.

He said that little was known about the natural stresses on mangrove systems and how human action interacted with natural stresses. Human action, moreover, created other stresses by interfering with nature, affecting flow patterns and introducing pollutants. The deforestation of mangrove areas was one of the most serious constraints affecting coastal marine ecosystems.

Dr. Snedaker also gave a short account of the research projects being conducted in Florida.

During the discussions on Theme III, Mr. A. Lugo said that, in many instances, governments did not use the findings of environmental studies to take measures aimed at reducing the environmental impact. He also said that there was frequently a communication gap between scientists and the engineers responsible for project design.

Theme IV: Population, demography and health

Leader of discussion: Marco Giglioli
Rapporteur: R. Alvarez

P. Barreto: "Salud humana y manglares" (Human health and mangrove areas).

J.F. Bouchard: "Pre-Columbian cultures of the equatorial Pacific littoral and their relationship with the ecosystem".

Discussion of this theme began with an address by Dr. Giglioli, who stressed the importance of mangrove studies in relation to man. Mangroves had been used traditionally as a source of wood for charcoal and for tannin, alcohol and a variety of other purposes. However, when people exploited the resources of mangrove areas and shared the latter's habitat by establishing urban settlements and developing agro-industrial projects, they were likely to benefit from the situation, but they were also liable to be exposed to a number of adverse factors.

The advantages included the well-known high biological productivity of mangroves and, in particular, the productivity of many commercially valuable species, representing a substantial source of income in many regions. But a number of mosquito species were closely associated with mangrove areas, and some of these were vectors of human and animal pathogens. The most widespread problem connected with mangrove areas was undoubtedly that of malaria.

Governments all over the world spent large sums on the control of such diseases. It had to be noted, however, that great care was called for in applying chemicals to mangrove areas in order to combat the vectors, for the unsupervised and repeated application of such substances could have very adverse effects on forests and on their flora and fauna.

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(1) SCOR = Scientific Committee on Oceanic Research.

The speaker concluded by stressing the importance of research into health factors and by calling the participants' attention to the need to take those factors into account in future studies of such coastal systems.

In the ensuing discussions, it was emphasized that prevention was one of the most important ways of dealing with many of the health problems of people living in mangrove areas. Their living conditions should be improved and settlements should be provided with better medical facilities. Moreover, the grave problem of malnutrition, which reduced body's resistance to disease, must be solved.

It was also noted that the indiscriminate use of insecticides could disturb or seriously damage the system. In some cases, owing to the amount of pesticides used, the predator population declined and insects accordingly tended to proliferate, although increasing and excessive quantities of pesticides were applied. The need to promote health education, which was regarded as essential, was also stressed.

Theme V: Resource utilization and economy

Leader of discussion: Gilberto Cintrón
Rapporteur: H. von Prahl

L.B. Cavalcanti: "Utilización de zonas de manglares en el Estado de Pernambuco, para fines de acuicultura" (Use of mangrove areas for aquacultural purposes in the State of Pernambuco).

C.R. Poli: "La acuicultura de manglares en la Universidad Federal de Santa Catarina, crianza de Mugil curema en tanques" (Mangrove acquaculture at the Santa Catarina Federal University: pond-breeding of Mugil curema).

C. Quiroz "Cultivo de langostinos en el Perú: estado actual e incidencias en el ecosistema de manglares" (Prawn-breeding in Peru: present situation and impact on the mangrove ecosystem).

H. von Prahl: "Importancia del manglar en la biología de los camarones Peneidos" (The importance of mangroves in the biology of Peneides shrimps).

R. Rojas Beltrán: "Diferencia estacionales en la productividad de un criadero natural de camarones peneides del manglar de Guadalupe (Antillas Francesas)" (Seasonal differences in the productivity of natural Peneides shrimp breeding-grounds in the mangrove areas of Guadeloup, French West Indies).

In his address, the leader of the discussion dealt with various aspects of the response of mangrove vegetation to direct and indirect human action. He gave data on the effects of sand deposition on a mangrove floor, weathering at different water-levels, and oil pollution. In all these cases, the mangrove depletion rate was due to the fact that the lenticel sections were covered by sediment and/or oil. The section of the roots where most of the lenticels occurred was roughly at the levels corresponding to the range of water-level fluctuations. The lenticel and pneumatophore levels were a pointer to the water levels in the system. When, as a result of changes in water level, these surfaces became covered by sediment or viscous substances such as oil or petroleum, the root system was prevented from breathing and the trees were liable to die.

On the subject of sand deposition, he described a case where, as a result of sand quarrying, the height of the long-shore dunes had been reduced from 10 metres to less than 3 metres. The reduction in height made it possible for large waves to overtop the dunes, causing large quantities of sand to invade the mangrove area. In places where the sand was deposited to a height of 30 cm - the maximum height of the lenticels above the mangrove floor - a transition belt was formed, where some of the trees survived, although they lost all their foliage. In places where the sand layer was higher, however, all the trees died. The forest was able to withstand sand deposition to a height of 20 cm. When the substratum changed, the vegetation also changed, and areas with a sand thickness of more than one metre were invaded by Casuarina. Areas subject to more frequent perturbations were colonized by Ipomea and grainineous plants.

With regard to the problem of oil penetration into mangrove areas, he described the impact of oil spillage on a mangrove in south-western Puerto Rico. Oil slicks were liable to penetrate deep into mangrove areas, owing to the absence of marked relief features. The extent of damage or penetration depended on the tidal situation and on the height of the mangrove floor in relation to tides. Windward coasts were liable to be more seriously affected, because the oil was pushed inland.

Once oil had penetrated into mangrove areas, it was impossible to clear it out completely. The complex system of prop and adventitious roots was covered with oil and acted as a storehouse, or reservoir. As the viscosity of the oil increased with the evaporation of the lighter parts, a blanket of debris and oil was formed around the roots, and this prevented gas exchanges.

In the course of the discussions, von Phral's findings on the consumption of wax by Penaeus stylirostris were examined in more detail. According to the research worker, this is a very clearly marked phenomenon from the second to the fifth post-larval stages, during which, unlike Penaeus occidentalis, they feed on the wax.

As regards the species bred in fishponds described by L.B. Cavalcanti, it was reported that Mugil and hybrid Tilapia would be used for the purpose. The latter species had produced yields of more than 11 tons per hectar per year in experimental ponds and seven tons per hectar per year in commercial ponds.

Theme VI: Perception of the mangrove environment and legislation

Leader of discussion: Peter Bacon
Rapporteur: E. Pérez

Dr. Peter Bacon presented his paper, entitled "Methodology for decision-making in the management of neotropical mangrove ecosystems", in which he pointed out that, although scientific research had been carried on in mangrove areas for several centuries, attempts to manage the systems had been made in very few areas. The science of mangrove management was in its infancy, owing to disagreements over the purposes of such management and to problems of perception, administration and implementation.

Traditionally, the use of mangrove areas in the New World had been an uncoordinated activity mainly conducted by private individuals. There was no centralized machinery at the national or regional levels for taking decisions about management. Many research workers had failed to realize that governments needed data in order to be able to take the relevant decisions, and they had done little to produce data that could be used for that purpose.

Mangrove areas in Latin America provided a livelihood and were the basis for subsistence economies in many regions. Such activities appeared to be compatible with the continued viability of the mangrove ecosystem. Other forms of exploitation, such as the production of charcoal, timber and salt, were also of importance.

Statistics on the use of these resources were either hard to obtain or non-existent, and it was therefore difficult to take decisions regarding the level and types of exploitation possible in the different mangrove areas.

Biologists had had difficulty in translating the aesthetic values of mangrove areas into monetary terms, and moreover the scientific importance of such areas had to be evaluated. No methodology existed for quantifying the value of genetic resources, particularly those of mangrove fauna.

It also had to be realized that some mangrove areas might be more valuable than others and that some zones within a given mangrove area might be more valuable than others. However, research was needed to verify this.

In instances where mangrove areas were used for agricultural purposes, it had to be borne in mind that the cost of legal reclamation had been prohibitive in most cases and that valuable mangrove areas had been turned into unproductive land of little ecological value.

Even so, some such projects had proved successful. Detailed data on soil deterioration, salinization and other factors were required for project evaluation purposes.

Moreover, in any development project due account had to be taken of the fact that there was necessarily a minimum size below which the impact of coastal productivity declined. If an inventory of mangrove areas were compiled, it would be possible to single out for conservation and protection those areas contributing most to the productivity of coastal waters.

One point to which, in Dr. Bacon's opinion, insufficient attention had been given and which called for closer investigation was the possibility of increasing mangrove productivity by exercising care in handling the system.

In conclusion, he said that the management of mangrove regions should cover the entire functional area involved, i.e., the catchment area, the mangrove proper and the coastal zone. There should therefore be a central body responsible for managing all these. One problem frequently encountered was the fact that the management functions were discharged by several different bodies and local authorities, and there was little or no co-ordination between them. Legislation governing management was necessary, but there was hardly any such legislation as yet in the region. Laws on management should be drafted as a matter of urgency by scientists familiar with the functioning of mangrove systems.

The principal point that emerged from the discussions on this theme was the need to recommend that the different countries involved should draft and promulgate effective legislation for the management of mangrove areas.

Mangrove areas, moreover, should be included in national development plans, so that priorities could be laid down for conserving and protecting them.

Theme VII: Rehabilitation, management and conservation

Leader of discussion: H. Lot-Helgueras(1)
Rapporteur: O. González

J.I. Hernández, P. von Hildebrand and R. Alvarez: "Algunas apreciaciones sobre la problemática y el manejo de manglares con especial referencia al sector de la Ciénaga Grande de Santa Marta, Colombia" (Comments on

(1) Since the person invited was unable to attend, there was no leader of the discussion and his paper was not presented.

the problems of mangrove areas and their management, with special reference to the Ciénaga Grande de Santa Marta swamp in Colombia).

G. de Salas: "Esfuerzo de un plan de investigaciones para el ecosistema de manglares de la Ciénaga Grande de Santa Marta, Colombia" (Outline plan for research on the mangrove ecosystem of the Ciénaga Grande de Santa Marta swamp, Colombia).

The problem of mangrove rehabilitation in areas which had been subjected to timber felling was discussed at length. It was reported that similar situations had been experienced in Viet Nam as a result of the use of herbicides, and natural regeneration had been extremely slow or had not occurred at all.

It was pointed out that the considerable volume of material remaining on the mangrove floor after timber felling and the size of the felling areas probably had an influence, in that they made it difficult or impossible for seeds to take root in those areas. The size of the felling areas should obviously be regulated by law, so that natural regeneration would be fostered by the penetration of seeds through the edges of the areas.

It was pointed out, however, that physical and chemical changes might take place in the soil which would make it difficult or impossible for regeneration to occur.

Another problem discussed was the fact that some areas that had been cleared of trees were overgrown by the fern Achrostichum.

Stress was laid on the need for studies on mangrove regeneration and the development of techniques for rehabilitating mangrove areas.

Theme VIII: Basic guidelines for the implementation of a pilot project for training and research on the mangrove ecosystem in Latin America

Leader of discussion: Ariel Lugo
Rapporteur: R. Rojas

The three themes dealt with by Dr. Lugo were as follows: (1) ecological aspects of mangrove areas from the standpoint of the analysis of systems; (2) professional ethics and the need to promote higher ethical standards among ecologists; and (3) a preliminary outline of the pilot project for training and research.

Under the first heading, Dr. Lugo outlined some of the principles underlying mangrove ecology, and said that, unlike the biomes formed by tropical rain forests, in which the constituent elements existed in quite closed cycles and losses from the system were very small, mangroves were an open system in which there were both inflows and outflows of materials. Because of their high productivity and high outflow rate, mangroves were a very important part of the ecology of coastal regions. However, that meant that mangroves were closely linked with terrestrial systems, since rivers carried down the nutrients they needed. The mangroves made use of the nutrients and then re-exported them in the form of leaf litterfall, some of which was converted into detritus. That was why disturbances in natural nutrient flows to mangroves seriously affected their structure and productivity.

Mangroves were classified under a number of physiographical types; there were riparian, belt, basin, island, dwarf and "hammock" mangroves. The most productive in terms of leaf litterfall yield was the riparian mangrove, which produced more than 3 gr/m^2/day. Dwarf mangroves, which were found in the poorer, less propitious environments, were characterized by leaf litterfall productivity rates of less than 0.5 gr/m^2/day. Factors which could contribute to stunted vegetation growth included

the severe climatic conditions at the latitudinal limits, extreme soil salinity concentrations and a variety of edaphic factors which had not yet been satisfactorily described.

Dr. Lugo also put forward the idea that the response which a system made to an environmental stress depended on the point at which that stress acted on the system. Stresses affecting primary energy flows were likely to have a greater impact on the functioning of the system than disturbances in energy flows within the system itself, despite the fact that those flows consisted of "higher-quality" energy. He went on to list the stresses in five broad categories, as follows: Type 1 - stresses affecting the nature of the primary energy sources reaching the system. Type 2 - stresses diverting part of the energy flows before they were integrated into the system. Type 3 - stresses causing losses in energy potential when the energy was fixed by photosynthesis (shortly before it was stored or before its structure was changed). Type 4 - stresses disturbing the structure of the system. Stresses in the fifth category were those causing an increase in the respiration of the system.

After discussing these points, the speaker showed a model illustrating the relationships and connections between natural and developed land resources, decisions as to land use, and the quality of life. The model showed that the quality of life improved initially with development, but declined as development continued. The model clearly indicated that the developing countries should preserve the balance of nature and that uncontrolled development was not an answer to a country's problem. The developing countries should therefore give high priority to the conservation of natural resources, especially in view of the fact that many ecosystems, including mangroves, were fragile, and decisions on ecosystem management should be taken on a sound scientific basis.

Dr. Lugo appealed to Latin American scientists to play a greater part in the taking of decisions involving their countries' natural resources and to observe high ethical standards among themselves, in order to ensure that the taking of such decisions were disinterested.

Lastly, Dr. Lugo briefly described the basic guidelines for the pilot project for training and research on the mangrove ecosystem in Latin America. These guidelines are set out in detail in Section 3 of this report.

3. GUIDELINES FOR A REGIONAL PROJECT ON RESEARCH AND THE TRAINING OF HUMAN RESOURCES(1)

Introduction

Most of the research and educational institutions in Latin America experience the same problems - poor library and laboratory facilities, shortage of funds, limited administrative backing, and over-worked staff. As a rule, university research workers have to spend too much time in teaching, and it is difficult if not impossible, for them to engage in field work. For badly paid scientists, this situation gives rise to serious ethical problems, and yet a considerable amount of research is done. However, while Latin American scientists are contending with this situation, the forests, lakes, rivers and coasts of most of the tropical countries of the continent are being swallowed up at an alarming rate by unplanned developments. For instance, the Council on the Quality of the Environment which acts as adviser to the President of the United States has predicted that 60% of all the tropical forests in the world will have disappeared by the year 2000.

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(1) This section of the final report was drafted by Ariel E. Lugo, mainly on the basis of his own ideas, but also in the light of the contributions made by the special commission and the plenary meeting of the seminar.

If this biological tragedy is to be averted, Latin American scientists must assume responsibility for giving their governments sound scientific advice that will facilitate the permanent management of their natural resources. The state of affairs today suggests, that these reasources are not being properly managed - indeed, they are being irreversibly exploited for the sake of short-term gain. If Latin American scientists are to discharge their responsibilities fully, they will undoubtedly need greater official support, and large-scale institutional reforms will have to be introduced if that support is to be fully effective. Since the economic well-being of a country and its ability to cater for the needs of the population depend on the sound management of its natural resources, it is imperative for the Latin American countries to develop their own ability to manage such resources permanently.

This report describes the types of research and training which would have to be provided in Latin America if it is to be capable of managing its natural resources wisely. Local leaders must realize that they should give more active support to the technical programmes being carried out in their countries. If a country fails to train its own experts in environmental matters, it will be at the mercy of mercenary biologists from other countries, who usually lack the interest and the understanding they need if they are to provide governments with sound advice.

Need for a new conception

A glance at the biological literature dealing with the tropics will reveal the importance given to taxonomic descriptions of species. Most of the published work is of an esoteric nature and is of scarcely any help in government decision-making. The studies in the biological sciences carried out in the tropics do little to encourage the protection of biological resources, and, in some instances, they do not even help to improve our understanding of complex ecosystems.

Studies of a more holistic nature are needed if we are to begin to rectify this disturbing state of affairs. One example of this type of study is the rain forest project in Puerto Rico (Odum and Pigeon, 1971). Surveys of the structure and functioning of tropical ecosystems must be undertaken on a broader basis. The failure of ecologists to speak out when genuine problems of world significance arise only results in decisions on resource management being taken by engineers, lawyers and laymen who have no experience of the field and often know nothing about it. The studies must be tackled at the same level of complexity as the problems of society. Since the problems of society are situated at the level of the regional ecosystem, research studies must be carried out at the same level, rather than on a species by species basis.

The training of scientists also should be holistic in approach. The curricula in many Latin American universities were designed for scientists who received their training in the last century, and it is not surprising, therefore, that tropical biologists should have great difficulty in conveying their ideas to government officials, engineers, lawyers, architects, and so on. While they are capable of conversing among themselves and probably with young field biologists, their training does not prepare them to use modern equipment, such as computers, remote sensors, serial analysers, etc. Lastly, tropical biologists will have to assert themselves more and play their part in the processes leading to the taking of decisions regarding the management of natural resources, if they are to have any influence on the management and conservation of biological resources in the tropics. Groups of scientists engaged in a variety of disciplines will have to work together in order to attain these goals and make more efficient use of the manpower resources available. However, the fact that a number of specialists make a joint study of an ecosystem does not necessarily mean that, that study will be interdisciplinary or holistic.

If a study is to be holistic or interdisciplinary, there must be a common goal and a unified theory, or else a single concept or model to which all the disciplines can contribute, and the results must be of greater significance and more far-reaching than those produced by individual studies. If studies of this type are to prove successful, a systems ecologist will be needed to weld the group together. Special attention must be paid to the training of such a person; a recommended study programme for that purpose is shown in Table 1.

Organization of training and research

Figure 1 was derived from the report of a Unesco meeting held in Thailand, at which the participants were asked to draw up a research and training plan for the study of mangrove areas in South-East Asia. It shows an integrated system in which decision-makers, directors, the public at large, ecologists, students, teachers and people engaged in other occupations work together in various ways to provide the optimum conditions for mangrove management. At the meeting in Colombia, we developed a similar plan for Latin America, which is shown in Figure 2. The main objectives of the Latin American mangrove ecosystem programme would be as follows: (a) to understand how the different types of mangrove ecosystem function and how they respond to stresses; and (b) to use the information generated by the programme in order to draw up plans for the use and rational management of such coastal ecosystems.

The programme would have a regional director who would be in charge of administration and contacts with a scientific council composed of Latin American research workers and government-appointed specialists from outside the region. The scientific council would recommend the lines along which the programme and the manpower resources assigned to it would function, and would give advice whenever required. We put forward both an educational and a research programme which the Regional Director would be responsible for carrying out. The educational programme would comprise three types of course: (a) refresher courses to keep officials and research workers abreast of developments; (b) courses for training new research workers and officials; and (c) specialized courses for providing trained personnel with up to date information on recent advances in the relevant scientific fields.

The research component of the programme comprises regional and local studies throughout Latin America. The group singled out the following geographical regions as possible locations for regional studies: the Pacific coast from Peru to Mexico; the Atlantic coast and the continental seaboard of the Caribbean, including the northern coast of South America from the Magdalena River to the Amazon; the coast of Brazil from Recife to Florianópolis; and the Caribbean island coastline plus the coasts of the Gulf of Mexico.

We propose that studies be carried out in each of these regional sectors on the inventorying of coastal mangrove reasources, the identification and quantification of environmental stresses, and the co-ordination of the work with local research workers. It is suggested that three types of research project be carried out at the local level, namely descriptive projects, experimental projects and long-term studies. The themes covered by these studies would be as follows: the structure and function of mangrove ecosystems, preparatory work for regional inventories, responses of ecosystems to stresses, and studies aimed at gaining information about how coastal ecosystems should be managed and rehabilitated. Table 2 gives a list of specific studies proposed at the plenary meeting of the seminar.

The training of scientists to carry out these programmes would have to comprise a basic curriculum for all participants, on which the different university programmes could be aligned, and this would be followed by specialized studies selected according to the interests of the individual scientists and the needs of society. Figure 3 shows a suggested basic curriculum and four possible areas of

specialization, one of which - systems ecology - would, at the higher levels, receive the full support of the programme. The specialized curriculum for systems ecologists is shown in Table 1. Similar curricula should be developed for each area of research.

Table 1 - Example of a suggested curriculum for the training of systems ecologists

YEAR I	YEAR II
Botany	Zoology
Algebra	Calculus II
Analytical geometry	Systems mathematics
Calculus I	Organic chemistry
Chemistry	Analytical chemistry I
Physics	Geology
English	English
Spanish	Spanish
YEAR III	**YEAR IV**
General ecology	Coastal ecology
Terrestrial ecology	Oceanography
Statistics	Limnology
Analytical chemistry II	Biology of invertebrates
Plant physiology	Meteorology
Animal physiology	Geomorphology
Humanities	Hydrology
Social sciences	Optional subjects (3)
Optional subjects (2)	

Table 2 - Suggestions for research on each region or type of mangrove

A. PHYSICAL FACTORS

Hydrology	Geology
Hydro-periodicity and water fluctuations	Soil types
Salinity (i) water (ii) soil	Man-induced factors
Tides	Dynamics of O_2/CO_2 in soils and water
Rainfall	
Runoff	Winds and solar radiation
Sedimentation	Natural disturbances

Temperature: (i) water; (ii) atmosphere
Nutrients: (i) water; (ii) soils

Relative humidity and temperature in the different forest strata

B. BIOLOGICAL FACTORS

Types of species

Interactions between species

Exotic species

Relations between plants and animals

Pests and diseases

Human ecology - mangrove use and management

Food chains

Demography in mangrove areas

C. STRUCTURE

Composition: flora-fauna

Zoning

Stratification

Biomass: (i) plants; (ii) animals; (iii) substratum

Index of complexity: height, number of species, density, base area

Leaf area index

Diversity index

D. FUNCTIONING

Exchange of gases, sediment, plants and animals

Leaf litterfall

Primary and secondary productivity

Recycling of nutrients

Decomposition

Tree growth

Microbial dynamics of detritus

E. REGIONAL RELATIONSHIPS

Inlet-outlet

Water

Salts

Organisms, plants, animals

Nutrients

Sediment

Organic matter

Pollutants - origin and destination

Geology and geomorphology

F. IMPACT OF MANGROVES ON COAST - FUNCTION

G. TEMPORAL CHANGES

Phenology

Succession

Man-induced changes

Changes in mangrove areas (+ or -)

H. EXPERIMENTAL PHASES

Plant and animal ecophysiology

Manipulation of communities

Experiments with pollutants on species and communities

Mangrove rehabilitation

Flora and fauna management

Potential uses and economic value of species

I. INTEGRATION PHASE

Integration models	Monitoring, for production of reports on: (i) aquaculture; (ii) agriculture; (iii)quarrying, and cost/benefit analysis
Publications containing integrated descriptions	
Interpretation of findings for public information	Innovative calculations on the value of mangrove areas
Recommendations on mangrove uses and management, legislation.	Alternative uses for coasts dominated by mangrove areas
Reduction of conflicts	(Optimum) runoff capacity of mangrove regions

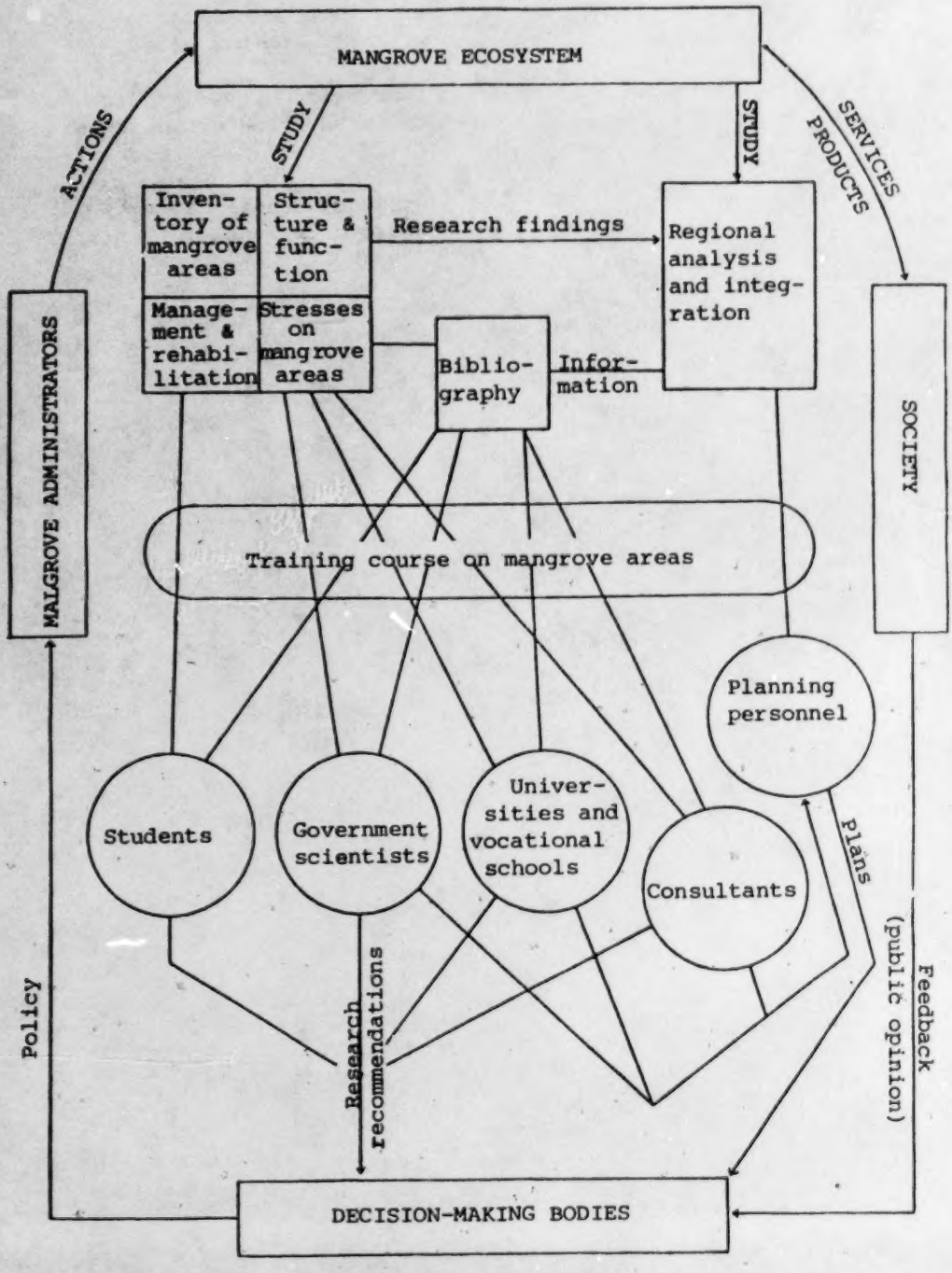
MANGROVE ECOSYSTEM
ACTIONS
STUDY
STUDY
SERVICES
PRODUCTS
Inventory of mangrove areas
Structure & function
Research findings
Regional analysis and integration
Management & rehabilitation
Stresses on mangrove areas
Bibliography
Information
MALGROVE ADMINISTRATORS
SOCIETY
Training course on mangrove areas
Planning personnel
Students
Government scientists
Universities and vocational schools
Consultants
Plans
Policy
Research recommendations
Feedback (public opinion)
DECISION-MAKING BODIES

Figure 1

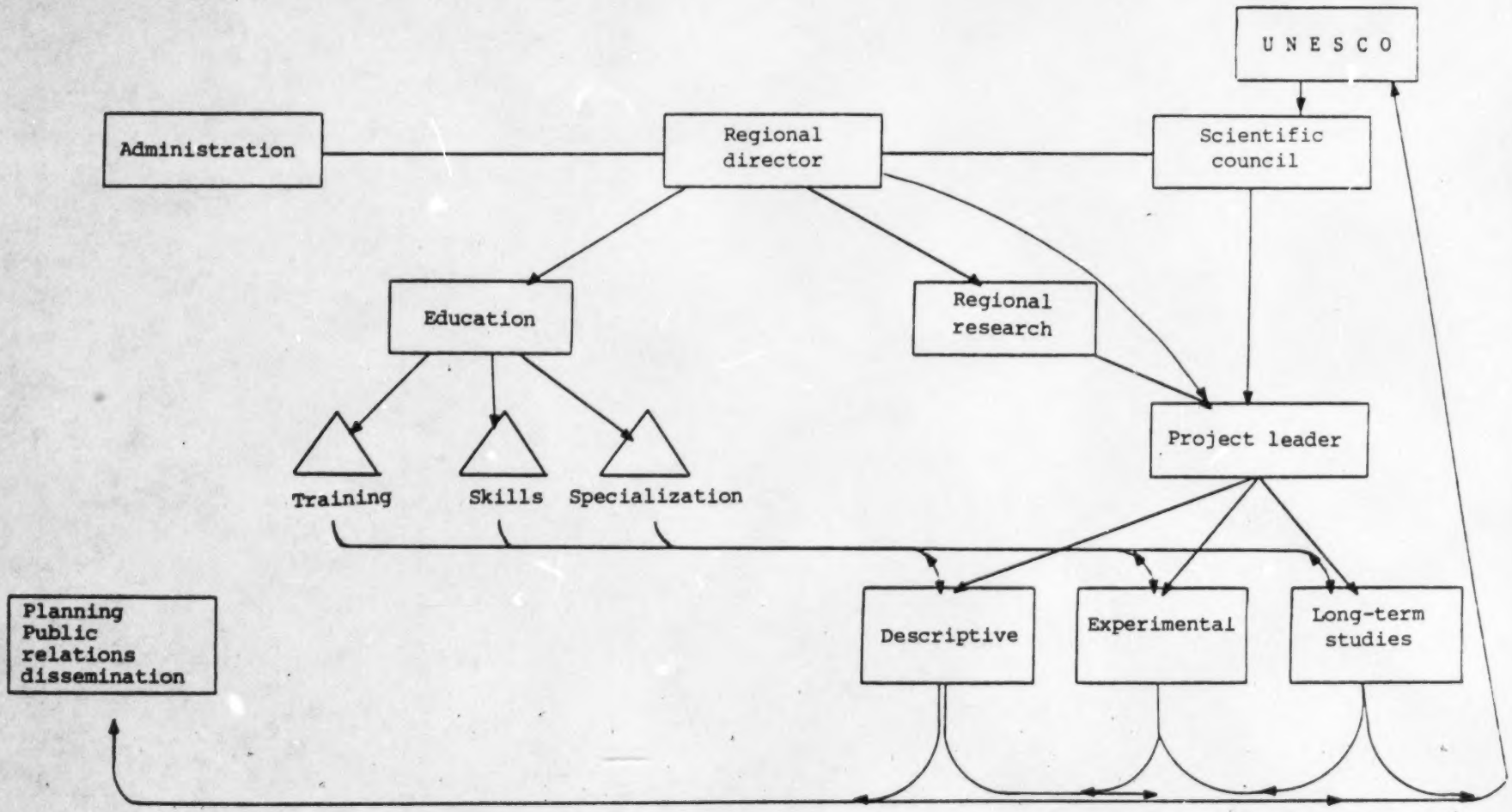

Figure 2 - Proposed organigramme for the training and research project on the mangrove ecosystem in Latin America

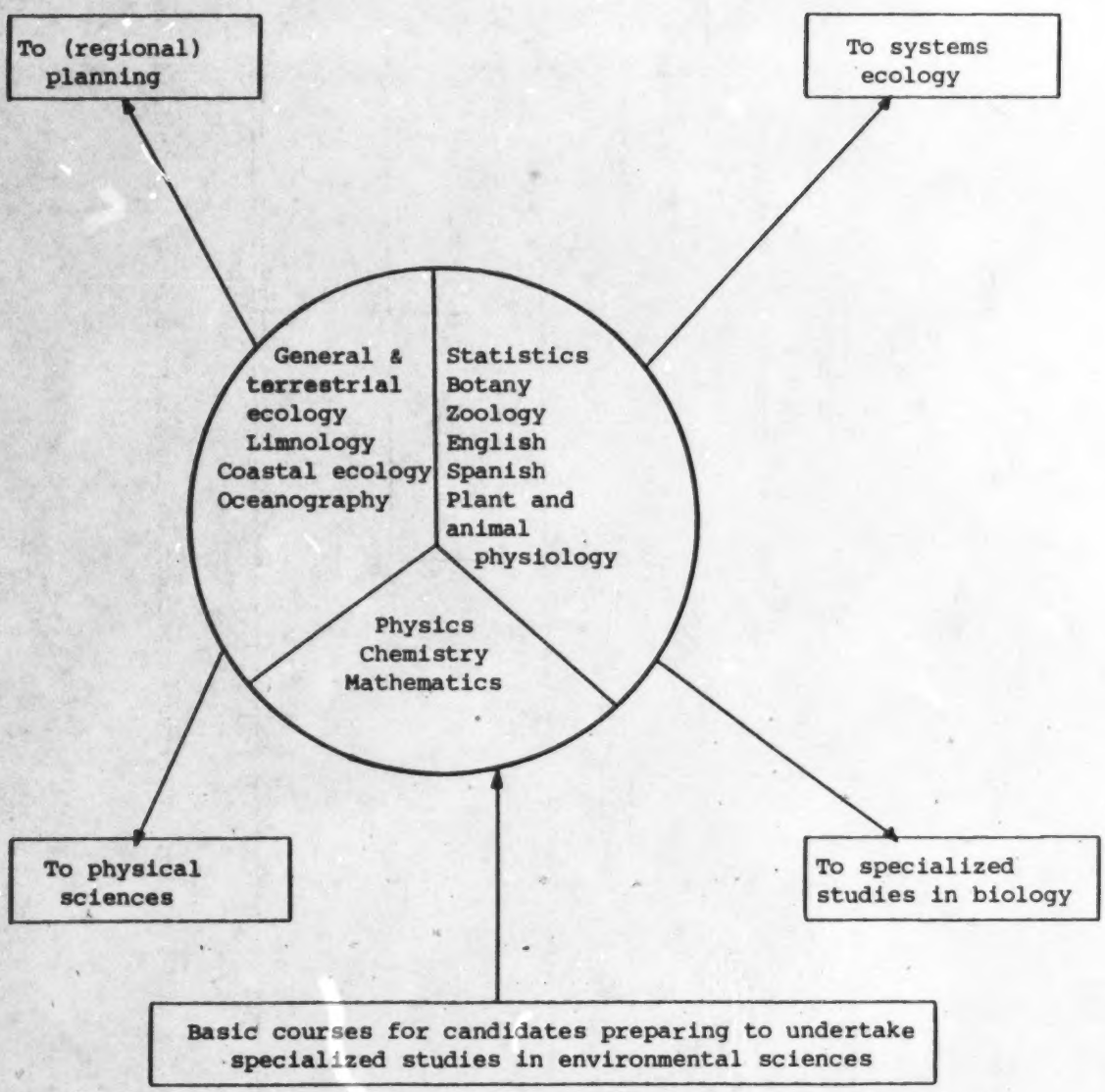

Figure 3 - Basic curriculum and specialized studies

4. CONCLUSIONS AND RECOMMENDATIONS

The participants in the seminar on scientific aspects of the mangrove ecosystem and the human impact on it,

Considering that:

1. all are agreed that it is desirable to obtain more information about the complex mangrove ecosystem in Latin America;

2. all efforts to understand those systems have so far been conducted in isolation in the individual participating countries;

3. at this meeting, for the first time, an attempt has been made to bring together research workers in this field;

4. there are extensive mangrove areas in Latin America, such as those on the Pacific coast of Colombia, where ecological data are virtually non-existent;

5. this type of meeting provides the best means of promoting contacts and fostering awareness of so important a subject;

6. one or more regional pilot projects conducted by Latin American scientists should be carried out in order to develop multidisciplinary and inter-institutional research in this field;

7. the organization of this seminar was completely successful and met with the general approval of the participants;

Recommends:

1. that the necessary steps be taken to ensure that the governments of the countries represented at the seminar held in Hawaii in 1976, or concerned by the resolutions adopted on that occasion, are familiar with the said resolutions;

2. that, surveys and inventories of mangrove areas be accordingly produced by the relevant governmental agencies;

3. that present and potential uses of mangrove areas be identified and listed and that the protein productivity of such ecosystems be determined and quantified;

4. that the ultimate aim of such studies be to determine the social and monetary value of the different types of mangrove areas according to whether they are fully or partly exploited, it being borne in mind that the most important consideration is to enhance the quality of human life;

5. that the biological studies carried out give prominence to continuous field work over long periods, for the purpose of quantifying biological aspects of importance for the conservation and utilization of mangrove resources;

6. that incentives be provided and conditions be created which will ensure that efforts to understand the mangrove ecosystem are pursued and strengthened by multidisciplinary and inter-institutional working groups, and that multidisciplinary studies be carried out concerning the situation of the human populations traditionally inhabiting mangrove areas and their relations with the ecosystem;

7. that native or hybrid species be used in aquaculture programmes, in order to ensure that the natural systems are not adversely affected by exotic species that are liable to jeopardize the environment;

8. that the functioning of the different types of mangrove areas in Latin America and their response to environmental stresses be studied exhaustively, so that any economic project involving such ecosystems can be preceded by an evaluation of the environmental impact;

9. that the information obtained be used to prepare plans for the rational utilization and conservation of these coastal ecosystems, stress being laid on the need to include them in the national development plans of the individual countries; and that due account be taken, whenever necessary, of the different conservationist strategies put forward by the International Union for Conservation of Nature and Natural Resources (IUCN) in 1978;

10. that all countries be advised to draw up and apply effective legislation for the management of mangrove areas;

11. regional projects should comprise:

    (a) an inventory of mangrove areas in Latin America;

    (b) an inventory of the stresses exerted on the natural resource they represent;

    (c) co-ordination of educational projects;

    (d) co-ordination of research;

12. sectoral projects should include:

    (a) structural and operational studies;

    (b) checking of the inventories made;

    (c) structural descriptions of the systems;

    (d) experimental studies;

    (e) responses to stresses;

    (f) rehabilitation and management;

13. the priority geographical areas for integrated research on mangrove ecosystems should be:

    (a) the Pacific coast, from Peru to Mexico;

    (b) the Atlantic and Caribbean seaboard and the northern coast of South America, from the River Magdalena to the Amazon;

    (c) Brazil, from Recife to Florianópolis;

    (c) the Caribbean islands and the coast of the Gulf of Mexico.

ANNEX I

PROGRAMME OF THE SEMINAR

Monday, 27 November

8.00 a.m. Registration

8.30 a.m. Preparatory meeting to appoint rapporteurs and set up commissions

9.30 a.m. Opening ceremony, under the chairmanship of the Mayor of Cali

Opening address by Dr. Ricardo Rojas Beltrán, National Co-ordinator of the Seminar

Address by Dr. Rodrigo Escobar Navia, Mayor of Cali

Address by Dr. Jorge Orlando Melo, Dean of Research of the University, on behalf of Dr. Alvaro Escobar Navia, Rector of the University.

11.00 a.m. Coffee break

THEME I: INVENTORY OF MANGROVE AREAS

11.15 a.m. Address by Dr. V.J. Chapman, Leader of the discussion on Theme I: "Inventory of mangrove areas"

2.30 p.m. G. Cintrón and C. Goenaga: "Observations on the development of mangrove areas on arid coasts"

2.50 p.m. F. Serrano: "Use of systematic compartments in the study of mangroves as ecosystems"

3.10 p.m. Coffee break. Receipt of requests to speak on Theme I

3.30 p.m. J. Palacio: "Variation of invertebrates in mangrove root formations (Rhizophora mangle) in the Ciénaga Grande de Santa Marta swamp"

4.00 p.m. Coffee break

4.20 p.m. N.B. de Pascuas: "Phytosociological characteristics of mangroves in the Tayrona Natural Park"

4.30 p.m. J.H. Torres: "Contribution to the knowledge of tannin and dye plants commonly encountered in Colombia"

4.50 p.m. Discussion on Theme I, the contributors of papers acting as members of the panel

5.10 p.m. Meeting of the Commission on Theme I

5.50 p.m. Reception for participants

Tuesday, 28 September

THEME II: STRUCTURE AND DYNAMICS OF THE MANGROVE ECOSYSTEM

8.30 a.m. Address by Mrs. Rosario de Pannier, Leader of the discussion on the Theme

9.30 a.m. M.B.B. Kutner: "Plankton in a mangrove area: Cananéia"

9.50 a.m. O. González and R. Baez: "Chart of mangrove volumes"

10.10 a.m. Coffee break. Receipt of requests to speak on Theme II

10.20 a.m. J.P. Lescure: "The architecture of mangrove forests in French Guiana"

10.40 a.m. A.E. Oliveira: "Distribution of estuarine fishes in north-east Brazil, in relation to salinity"

11.00 a.m. C. Villalobos: "Biotic resources in coastal lagoons, mangroves and adjacent areas in Latin America"

11.20 a.m. M. Espinosa: "Intertidal sessile fauna of mangroves in relation to a number of environmental parameters in the Laguna de Términos, Campeche"

11.40 a.m. F. Lachica: "Spatial and temporal diversity of benthocenosis in the estuary of the River Coatzocoalcos, Veracruz"

12.00 noon Lunch

2.30 p.m. C. Flores: "Mangroves as a haven and substratum for faunistic components"

2.50 p.m. P.N. Coutinho: "The mangroves of the coastal plain of Recife"

3.10 p.m. Coffee break. Receipt of requests to speak on Theme II

3.30 p.m. J.R. Cantera, R. Contreras, F. Borrero, E. Buttkus, F. Zapata: "The natural history of the mangrove gasteropod Thais kiosquiformis Duclos, 1832, on the Pacific coast of Colombia"

3.40 p.m. R. Horna: "The soil-mangrove relationship (Rhizophora mangle, Conocarpus erectus, Laguncularia racemosa, Avicennia nitida)"

4.00 p.m. J.M. de Morais, G.S. Sá Freire, P.N. Coutinho: "Intertidal flat sedimentation on the Bacanga River Estuary"

4.20 p.m. María E. Pérez and Carlos H. Victoria: "Aspects of the invertebrate community living among the submerged roots of the red mangrove in Cartagena Bay"

4.40 p.m. Coffee break

5.00 p.m. H. Quiróz and G. Vernett: "Benthonic foraminifera in mangrove areas and their relationship to the ecosystem (Tierra Bomba, Cartagena)"

5.20 p.m. Discussion of the paper presented, the contributors of papers acting as members of the panel

5.40 p.m. Meeting of the Commission on Theme II.

Wednesday, 29 November

THEME III: NATURAL AND ARTIFICIAL STRESSES ON THE MANGROVE ENVIRONMENT

8.00 a.m. Address by the Leader of the discussion on the Theme, Dr. Samuel Snedaker

9.30 a.m. L.B. Cavalcanti, P.A. Coelho, E.E. Leca, J.A.C. Luna, S.J. de Macedo and M.N. Paranaguá: "Ecological conditions in the Suape area (Pernambuco, Brazil)"

9.50 a.m. D. Mizrachi and F. and R. Pannier "Lorantaceae as infective agents disturbing the equilibrium of mangrove areas", and "Strategies for the introduction of Conocarpus erectus"

10.10 a.m. Coffee break. Receipt of requests to speak on Themes III and IV.

THEME IV - POPULATION, DEMOGRAPHY AND HEALTH

10.20 a.m. Address by the Leader of the discussion on the Theme, Dr. Giglioli

11.00 a.m. P. Barreto: "Human health and mangrove areas"

11.20 a.m. J.F. Bouchard: "Pre-Columbian cultures of the equatorial Pacific littoral and their relationship to the ecosystem"

11.40 a.m. Discussion on Themes III and IV, the contributors of papers acting as members of the panel.

12.40 p.m. Visit to the Staff Hall of the Universidad del Valle

1.00 p.m. Lunch and afternoon spent at the Staff Hall

6.00 p.m. Return to Cali.

Thursday, 30 November

THEME V: RESOURCE UTILIZATION AND ECONOMY

8.30 a.m. Address by the Leader of the discussion on the Theme, Dr. Gilberto Cintrón

9.30 a.m. Coffee break

9.50 a.m. L.B. Cavalcanti et al. "Use of mangrove areas for aquacultural purposes in the State of Pernambuco"

10.10 a.m. C.R. Poli and F.N. Snizek: "Mangrove aquaculture at the Santa Catarina Federal University: pond-breeding of Mugil curema"

10.30 a.m. Break

12.00 noon Lunch. Meeting of Commissions

2.30 p.m. C. Quiróz: "Prawn-breeding in Peru: current situation and impact on the mangrove ecosystem"

2.50 p.m. H. von Prahl: "The importance of mangroves in the biology of Peneides shrimps"

3.10 p.m. R. Rojas Beltrán: "Seasonal differences in the productivity of natural Peneides shrimp breeding-grounds in the mangrove areas of Guadeloupe, French West Indies"

3.30 p.m. Coffee break. Receipt of requests to speak on Theme V

4.00 p.m. Discussion on Theme V, the contributors of papers acting as members of the panel.

THEME VI: PERCEPTION OF THE MANGROVE ENVIRONMENT AND LEGISLATION

5.00 p.m. Address by the Leader of the discussion on the Theme, Dr. P. Bacon

6.00 p.m. Meeting of Commissions.

Friday, 1 December

THEME VII - REHABILITATION, MANAGEMENT AND CONSERVATION

8.30 a.m. Address by the Leader of the discussion on the Theme, Dr. H. Lot-Helgueras

9.30 a.m. J.I. Hernández, P. von Hildebrand and R. Alvarez: "Comments on the problems of mangrove areas and their management, with special reference to the Ciénaga Grande de Santa Marta swamp in Colombia"

9.50 a.m. Coffee break. Receipt of requests to speak on Themes VII and VIII

10.10 a.m. P. von Hildebrand and G. de las Salas: "Outline plan for research on the mangrove ecosystem of the Ciénaga Grande de Santa Marta swamp, Colombia"

THEME VIII - BASIC GUIDELINES FOR THE IMPLEMENTATION OF A PILOT PROJECT FOR TRAINING AND RESEARCH ON THE MANGROVE ECOSYSTEM IN LATIN AMERICA

10.30 a.m. Address by the Leader of the discussion on the Theme, Dr. Ariel Lugo

12.00 noon Lunch. Meeting of Commissions

2.30 p.m. Discussion on Themes VII and VIII, the contributors of papers acting as members of the panel

3.30 p.m. Coffee break

3.50 p.m. Meeting of Commissions

4.50 p.m. Plenary meeting to approve the conclusions and recommendations

6.00 p.m. Closure of the Seminar.

BACON, P.R.: Metodología para tomar decisiones para el manejo y la utilización de ecosistemas de manglares neotropicales. (Methodology for decision-making in the management of neotropical mangrove ecosystems)

Since mangrove ecosystems are located on the seaboard, they are liable to be reclaimed for urban or industrial development or for agricultural purposes. Valuable properties have been developed, land suitable for cultivation has been cleared and in many places troublesome insects have been controlled through drainage and back-filling operations. In their natural state, mangrove areas contain useful resources such as timber, crustaceans, including crabs, and fish. The value of such resources is seldom higher than the cost of the land. The economic yield of tourism and scientific research can be quantified, but is relatively insignificant, and the role of mangroves in coastal production or as cultivated areas has not been properly documented.

This paper reviews neotropical experience of the development of natural and improved mangrove areas and discusses the problems which have arisen in the course of improvements made for agricultural purposes and of attempts to manage natural ecosystems. It suggests a methodology for determining the relative values before taking decisions concerning development, and indicates areas in which research should be pursued.

BARRETO, P.: Salud humana y manglares (Human health and mangrove areas)

The ideas set forth in this paper on the relationship between human health and the mangrove ecosystem apply only to the situation on the Pacific coast of Colombia. Although very few people live in that area, respiratory and digestive diseases are common, especially among young children, and are responsible for the high sickness and mortality rates.

Malaria, viral fevers, filariasis and leishmaniasis are prevalent, since the environment favours the development of a variety of effective vectors for the pathogens causing such diseases. Moreover, there are other arthropoda which, on account of their haematophagous habits, become a veritable scourge and have an adverse effect on the health and economic productivity of people living in mangrove areas.

BOUCHARD, J.F.: Las culturas precolombinas del litoral Pacífico ecuatorial y sus relaciones con el ecosistema (Pre-Columbian cultures of the equatorial Pacific littoral and their relationship with the ecosystem)

The pre-Columbian cultures of the equatorial Pacific littoral (La Tolita-Esmeraldas in Ecuador and Tumaco in Colombia) attained a high level of social and technological development, especially in the period between 500 B.C. and at the beginning of our era. These cultures had a mixed economy based on the exploitation of the substantial fishery resources of the region and a rudimentary form of agriculture in the lower part of the alluvial plain located behind the mangroves. Since salt water entered the river mouths and inlets through the action of the tides, marine ichtyologic fauna can be found in the mangrove areas and even further inland where there were human settlements. At that time the inhabitants could fish in the vicinity of the settlements, without having to go to the sea. Furthermore, because they could fish for marine species, they were assured of larger catches, and there was less danger of exhausting the fishery resources, since the mangroves were natural breeding-grounds for fish and crustaceans. The fact that it was possible to obtain plenty of protein from fish and to engage in rudimentary agriculture on the alluvial plain, where the soil was of better quality than along the coast and in the foothills, probably meant that they had an abundant and well-balanced food supply, and the economy was therefore stable enough for highly developed cultures to become established in the region.

CANTERA, J.R.; CONTRERAS, R.; BORRERO, F.; BUTTKUS, E.; and ZAPATA, F.: Historia natural del gasterópodo del mangle Thais kiosquiformis Duclos, 1832, en la costa Pacífica de Colombia (The natural history of the mangrove gasteropod, Thais kiosquiformis Duclos, 1832, on the Pacific coast of Colombia)

Thais kiosquiformis is a predator of oysters, cirripedia and other gasteropods, and lives in the roots and trunk of the red mangrove (Rhizophora mangle and R. brevistyla), as well as on intertidal rocks and man-made wood and concrete structures. It is found from Lower California to Peru (Keen, 1971; Morris, 1966). In Colombia, it lives in several estuarine areas from Ensenada de Catripe (4°25'N and 77°18'W) to Tumaco (1°50'N and 78°44'W), (Cantera and Contreras, 1977).

The average size of individual specimens collected at six localities - Ensenada Catripe, Bahía de Málaga (3°56'N and 77°22'W), Bahía de Buenaventura (3°53'N and 77°06'W), Ensenada de Guapi (2°35'N and 77°56'W), Playa Mulatos (2°40'N and 78°16'W), and Tumaco - was 36.36 mm.

Studies of this species' feeding habits have shown that it lives on cirripedia, Ostrea conchaphila and young Littorina zebra, L. varia and Cerithidea valida. Under laboratory conditions, two specimens tried to devour individuals of the same species by piercing their shells.

Factors connected with reproduction, development and growth were studied, with the following findings: the ovigerous clusters displayed a variety of circular or elongated shapes ranging from 5.0 to 23 cm in length and from 7.9 to 9.8 cm in width. The number of eggs laid at each oviposition varied between 40 and 1,000, each of them being cylindrical in shape and measuring, on average, 5.54 mm long and 2.1 mm wide. The females lay their eggs either separately or together, in shady areas, for instance, underneath or inside tree-trunks.

The paper describes various aspects of copulation, oviposition and development.

Growth was measured in terms of both length and weight, using individual specimens which had already reached the stage where they had become attached to the substratum. The average monthly growth for all specimens amounted to 0.54 mm and 0.29 grams. The shell and the radula undergo changes as size increases.

The paper includes an analysis of the population variation in the course of time, using the modal phase shift method, over a one-year period, together with a study of the morphological and morphometrical variations in the shell and the radula as the specimens grow, by means of a regression analysis.

CAVALCANTI, L.B.; COELHO, P.A.; LECA, E.E.; LUNA, J.A.C.; MACEDO, S.J. de; PARANAGUA, M.N.: Utilización de zonas de manglares en el Estado de Pernambuco (Brasil) para fines de acuicultura (The use of mangrove areas for aquacultural purposes in the State of (Pernambuco, Brazil))

In 1966, the Oceanography Department of the Federal University of Pernambuco, Brazil, began work on the setting up of an estuarine fish-breeding station on the island of Itamaracá, 50 kilometres to the north of the city of Recife. The station now has 28 fish ponds, covering a total area of 10 hectares.

The main purpose of the work being done is to formulate, in the near future, a policy for developing the breeding of fish and crustaceans in the extensive mangrove areas in the State, including selection of the species that are most promissing from the standpoint of productivity.

Experiments in semi-intensive mixed-species breeding have been conducted with Mugil curema, M. brasiliensis (Mugilidae), Centropomus undecimalis, C. paralellus (Centropomidae) and Diapterus olisthostomus, D. rhombeus and Eugerres brasilianus (Gerridae). Tests have also been started with Penaeus brasiliensis.

The above-mentioned species are already being farmed with some success. Natural feeding is used, although artificial feeding and fertilization of the water to ensure high productivity are not ruled out.

In addition to these aquacultural activities, studies are being carried out on the chemical composition of the water, phytoplankton and zooplankton, feeding, parasitology and the biology of reproduction. Yields ranging between 400 and 1,500 kg/hectare/year have been obtained.

CAVALCANTI, L.B.; COELHO, P.A.; LECA, E.E.; LUNA, J.A.C.; MACEDO, S.J. de; PARANAGUA, M.N.: Condiciones ecológicas en el área de Suape (Pernambuco - Brasil) (Ecological conditions in the Suape area (Pernambuco, Brazil))

The Government of the State of Pernambuco proposes to set up an industrial port complex in the Suape area, and this will undoubtedly give rise to environmental changes. It was accordingly necessary to carry out an ecological study of the area, so as to describe the existing situation (in terms of the distribution of living organisms and the factors governing them), determine what the effects of the project would be and put forward suggestions on how it could be carried out while causing as little damage as possible. Specimens of benthos and of phytoplankton and zooplankton and samples of water for purposes of chemical and physical analysis are being collected. As an initial step, studies are being carried out in the southern part of the area which includes the cape of Santo Agostinho, the Suape reefs, the bay of Suape, the Massangana estuaries and the rivers Tatuoca and Ipojuca. During the period when the studies were being carried out, the water regime in the bay of Suape was marine or polyhaline, whereas it was marine, polyhaline and mesohaline in the estuaries of the Massangana and Tatuoca. The regime in the estuary of the river Ipojuca varied from polyhaline to limnetic.

The dissolved oxygen content varied in general from 2 to 5 ml/l, the lowest values being found in the estuaries of the Massangana and the Ipojuca, where it declined to zero.

The plankton and benthos varied accordingly, and were richer and more varied as the degree of salinity and dissolved oxygen content increased. The fall in salinity and dissolved oxygen content produced a qualitative decline in fauna and flora, with some groups predominating.

CINTRON, G.; GOENAGA, C.: Observaciones sobre el desarrollo del manglar en costas áridas (Observations on the development of mangrove areas on arid coasts)

Mangrove areas rarely develop in arid regions because there are no sediment deposits to build up the coastline and prepare the substratum for mangrove colonization. Observations made in areas of low rainfall in Puerto Rico and adjacent islands and in southern Florida, U.S.A., where evaporation levels are high and the tidal range is small, show that soil salinity governs the structural complexity of the forest, the succession patterns and the width of the mangrove belt. In all the arid areas investigated, the mangrove belts or forests had the following characteristics: an outer belt composed of red mangrove Rhizophora mangle, with an average surface salinity of 37 per mille and an average pore salinity of 38 per mille; an inner belt of black mangrove Avicennia nitida, with a surface salinity of 48 per mille and a pore salinity of 59 per mille; and a hypersaline lagoon in which dead trees are frequently to be found and in which the average salinity levels amount to 56 per mille in the surface water and 84 per mille in the pore water. Behind this belt, there are saltpans with surface salinity rates of 72 per mille and pore salinity rates of 102 per mille or even higher. Salinity levels of more than 90 per mille prevent mangroves from developing while growth is stunted at levels between 70 and 90 per mille.

In the forests investigated which have salinity rates of about 17 per mille ($r = 0.75$), the height of the mangrove is in inverse proportion to pore salinity. The length of Rhizophora leaves is also affected in inverse proportion to pore salinity ($r = 0.75$), so that the lower the pore salinity the greater the leaf size.

The succession patterns were studied from the interpretation of aerial photographs taken between 1936 and the present day, from which it was found that, contrary to the classical pattern described in the literature on the subject, the zoning in two of the mangrove areas investigated was due to the preferential establishment of the species rather than to their actual succession. Rhizophora took root on sandbanks or reefs, leaving a shallow lagoon between the outer mangrove belt and the mainland, and this lagoon was subsequently invaded principally by Avicennia. It is suggested that cyclical changes in rainfall and storm occurrence are factors governing succession patterns. When the outer belt of Rhizophora has formed and Avicennia has taken root in the inner lagoon, there may be a gradual increase in the salinity of the inner parts of the mangrove as a result of drought and/or the active growth of the outer rim. The increased salinity kills off the mangroves and may cause the area of hypersaline lagoon to increase. However, periods of stormy weather or rainfall may open up fresh channels and wash away the salt from the inner parts of the mangroves, so that they can grow again in such areas. In less well protected coastal mangroves, the deposition of sand berms or ridges prevents the water from flowing into the inner part, and this causes the trees in the inner part to die. Optimum conditions for development therefore occur in coastal sectors that are afforded better protection from storm waves which, although not destroying the mangroves, may nevertheless give rise to the emplacement of sand ridges.

COUTINHO, P.N.: Los manglares de la planicie costera de Recife (The mangroves of the coastal plain of Recife)

The muddy soils of mangroves are one of the main sedimentary environments on the coast at Recife. The texture and composition of the sediments in the mangroves reflect the geological, bathymetric and hydrological conditions in which they were deposited.

Inland from the coastal inlet, the formations encountered are, firstly, a vegetationless mud flat, followed by a grassy area, then an area of mangrove shrubs and, lastly, a zone of tall mangrove vegetation. The species represented in the last-mentioned area are Rhizophora mangle L., Laguncularia racemosa Gaerth, Avicennia sp and Conocarpus erectus L.

The low-lying mangrove areas are composed of roughly equal proportions of clay and silt and a small percentage of fine sand, but the high-lying mangrove areas are chiefly composed of sand and a small amount of mica and mud. Some 40 to 50 per cent of the clay fraction consists of kaolinite, while illite and montmorillonite are present in equal quantities. The calcareous material consists of micro-organisms and fragments which are generally cemented with black organic matter or iron sulphide. The organic carbon content varies between 3 and 7 per cent, but may amount to as much as 10 per cent in some instances. The nitrogen content ranges between 0.13 and 0.40 per cent. The concentration of nutrients reflects the marked influence of the water flowing out of the mangrove area and of the pollution occurring in areas upstream.

Owing to the considerable impact of human intervention within the city as a result of the drainage, canalization and backfilling works carried out for urban housing purposes, the conditions which the mangroves need to survive are gradually disappearing.

CHAPMAN, V.J.: La vegetación de los manglares: una revisión (Mangrove vegetation a survey)

Mangroves can be divided into two main groups: those of the Old World and those of the New World. Although they are generally found on a mud or a mixed sand and mud substratum, they may also be found in association with brackish-water swamps, as in Louisiana, or with coral formations, as on the Great Barrier Reef. The main forms of association can be identified by means of the Montpellier system of classification. The subdivisions of these associations occur naturally in all areas where detailed studies are being conducted. This is true of the detailed routine investigations being carried out in New Zealand. Some changes, as well as speciation, may also have taken place over the course of time. The latter process is illustrated in particular by the recent identification of Rhizophora racemosa, R. harrisonii, Avicennia bicolor and A. schaueriana in that region. Information has recently been received about species from Indonesia that have been found on the eastern coast of India. This is particularly interesting, since it confirms the idea that propagation originally took place via India, the Red Sea and the Mediterranean. Attention has also been called to the mangrove groups found in the Atlantic and Pacific regions.

Although the general physiognomy of the mud substratum is provided by the mangrove genera, at least four algae communities can be identified and, in some instances, a phanerogamous community may be associated with the mangroves, as is Zostera muelleri in New Zealand. All these plants are primary producers and form the basis of an intricate food chain which is illustrated in the paper. Reference is made to the faunistic studies carried out, and it is noted that, although the Indian and Pacific Ocean region is well documented as a result of the studies carried out by the late Dr. MacNae, little is known about other areas, including Central, North and South America, and these could be a valuable field of study, particularly in regard to biogeographical relationships. Many of the animals are visitors from other habitats, but it is possible to identify a basic mud fauna, part of which is specific to particular regions.

Six faunistic habitats are listed, while special reference is made to a community of insects specific to the crowns of trees. This community is to be found in two mangrove areas in New Zealand; it produces a dark-coloured mould, which gives the trees a blackish appearance.

Lastly, mention is made of the soils of mangroves in different communities, and it is emphasized that they, like the aerated layer of the soil, have not yet received the attention they should be given.

ESPINOSA, M.: La fauna sesil intermareal del manglar relacionada con algunos parámetros ambientales de la Laguna de Términos, Campeche, México (Intertidal sessile fauna of mangroves in relation to a number of environmental parameters in the Laguna de Términos, Campeche, Mexico)

This paper consists of a study of the sessile fauna of the intertidal area, carried out at three points on the Términos Lagoon at Campeche, with special reference to variations in their distribution and relative numbers as these relate to salinity, temperature, tides and substratum availability. The study is based on five samples taken in the course of each of the four seasons in the year March 1973 to March 1974. The different samples show that salinity and substratum availability are the main factors affecting the number and distribution of the different species encountered. Some of them display a broad degree of tolerance to changes in the physical parameters examined in the paper. The zoning pattern for individual specimens is dictated to some extent by the tides, but the tidal range is not a problem, since it does not give rise to periods of exposure and desiccation that are prejudicial to the fauna. The dominant species are Balanus improvisus (crustaceans and cirripedia), Crassostrea rhizophorae and C. virginica (molluscs and bivalves). The two last-mentioned species are of considerable importance in commercial fishing in the area.

FLORES, C.: El manglar como refugio y substrato de componentes faunísticos (Mangroves as a haven and substratum for faunistic components)

In the coastal mangroves of Venezuela, the crab Aratus pisonii lives in the roots and trunks of trees; it even reaches as far as the foliage, and feeds on the fruit of Rhizophora sp. Gasteropod molluscs of the genus Neritina are found in areas where the roots are less compact but there is some shade. Members of the Littorinidae family (Littorina angulifera and L. tessellata) and of the Muricidae family (Thais trinitatensis) live on epigeal roots and in the trunks of mangroves. Chicoreus brevifrons creeps over Rhizophora roots in search of the oyster Crassostrea rhizophorae, a species which grows in large numbers on the prop roots that form their best-known natural substratum. Other organisms, such as branching and membranous bryozoan sponges, ascidian tunicates and bivalves (Isognomum and Pteria), also use the mangrove as a substratum.

The mangrove floor is a very important environment, for in coastal areas where solar radiation is intense the mangrove affords protective shade for organisms which can live in the shelter of its foliage:

(i) Nerita fulgurans is a gasteropod living on the mangrove floor round the base of the trunk. It grows to a greater size in this biotope than in the rocky biotope of areas that are more or less exposed.

(ii) Batillaria cf. minima is a gasteropod found in large numbers in the sandy silt soils of mangrove areas, in short and clearly defined belts.

(iii) In the Chacopata mangroves on the northern coast of the State of Sucre, Melampus sp. is found in abundance in the wet mangrove soil.

As a result of the burrows and holes they dig as homes, the large numbers of decapod crustaceans contribute to the ventilation of the mangrove floor. The most important specimens of the Decapoda genera are Cardisoma, Uca, Sesarma, Goniopsis and Ucides. There are some ten species of Uca on the coasts of Venezuela. Cardisoma guanhumi, Goniopsis cruentata and Aratus pisonii are all climber species.

GIGLIOLI, M.E.C.: Población, demografía y salud (Population, demography and health)

Mangrove areas are found on the littoral between the two tropics and regions beyond. The total population of the countries which have coastal mangrove areas accounts for almost three-quarters of the world's population, and such areas are among those most seriously affected by the tropical diseases associated with insect vectors and a high density of endemic species.

In terms of population density and socio-economic levels, the populations living on the edges of swamps can be divided into three basic categories. Their subsistence depends on relatively scattered and poor settlements. In agro-industrial economies, where the larger communities frequently enjoy higher standards of civic infrastructure, including public health and hospital services, recreational facilities and urban utilities, population densities are high and sophisticated health services are available.

Although very few people are actually inhabitants of mangrove areas in the sense that they reside there and spend their lives in the vicinity of mangrove forests, large numbers live on mainland promontories which jut out from the coastline and the mangrove shores for distances of up to 25 miles but still remain in permanent day-to-day contact with the swamp areas.

Lastly, most mangrove areas in the Third World are occupied by rural settlements that are at the very bottom of the socio-economic scale. They have a high rate of tropical diseases, they face acute illness with stoicism, and they have to cope with the problems of harmful insect bites, whereas mangrove areas in the developed world

are often fitted out as vacation resorts and enjoy very high and sophisticated standards, and expensive public health facilities and technology are available for combating disease.

Although a great deal of information on the demography and health conditions of mangrove areas is available in the literature, there has been no attempt to relate it specifically to that habitat. The task would be difficult, especially since in most of the material published there is no mention of the presence or proximity of mangrove areas.

GONZALEZ, O.A.; BAEZ, R.E.: Tabla de volúmenes para manglares (Chart of mangrove volumes)

This paper describes the method used in compiling a volume chart for Rhizophora mangle, and also refers to the other mangrove species.

The introduction gives a brief account of the situation in regard to mangroves in Cuba and of the species composing them, and describes the area selected for study. There is a description of the methodology used, which is based on the studies carried out by the Technological Institute for Forestry in Moscow and on the "Instructions for Forestry Development in Cuba". The main findings reported in the paper are as follows:

1. It was ascertained that mangroves can be exploited under existing conditions in Cuba and can be regarded as being a latifoliate community.

2. The morphio coefficient was determined for the main mangrove species (Rhizophora mangle and Avicennia nitida).

3. It was confirmed that, with the exception of the red mangrove volume charts are not required for the remaining species, since the results obtained are similar to those available for other latifoliates with the same morphological coefficients.

HERNANDEZ, J.I.; HILDEBRAND, P. von; ALVAREZ, R.: Problemática del manejo de manglares con especial referencia al sector occidental de la Ciénaga Grande de Santa Marta, Magdalena, Colombia (The problems of mangrove management, with special reference to the western sector of the Ciénaga Grande de Santa Marta swamp, Magdalena, Colombia)

The area studied, on the northern coast of Colombia on the Caribbean seaboard (latitude 10°10' and 11°35'N and longitude 74°14' and 74°51'W), is described in terms of its geology, climate, limnology and biology. The hydrobiological conditions obtaining in the Ciénaga swamp are extensively reviewed for the purpose of carrying out a productivity analysis and comparing the value of the mangroves to the timber industry with the value of small-scale fishing activities.

The conclusion reached is that most benefit would be derived from the mangroves in the Ciénaga Grande by combining fishing with the exploitation of other resources directly or indirectly related to the ecosystem, such as "babillas", alligators and iguanas.

HORNA, R.: Relación suelo - mangle (Rhizophora mangle, Conocarpus erectus, Laguncularia racemosa, Avicennia nítida (The soil-mangrove relation (Rhizophora mangle, Conocarpus erectus, Laguncularia racemosa and Avicennia nitida))

This paper examines the relation between mangroves and the soil. The morphological and sedimentary diversity of the Gulf of Guayaquil is due to the considerable force exerted by the bottom and surface currents of the Rivers Babahoyo and Daule. The facies observed consist of delta formations, sandbank shelves, basal transgressions and upper slopes. The lithology is determined by the source materials, by climatic and biological action and by the effects of currents, tides and wave movement.

Whether the soil is clayey, sandy or rocky, it limits normal growth and development of the root, stem, trunk and leaf systems of the mangrove species examined. As a rule, these show distinct signs of rachitis: the leaves turn yellow and display marked cracking, while the stem and trunk, in addition to being slender and weak, become brittle and very fragile. They grow to an average height of 4 metres, with a stem radius of 10 cm.

The best soils proved to be pure clay or clay-silt formations with mud-like properties, a high capacity of water and organic-matter retention and outstanding mineral-nutrient availability. Under such conditions, the mangroves grow to an average height of 18 metres, with a stem radius of 40 cm.

KUTNER, M.B.: Estudios de plancton en una región de manglar: Cananeia (Lat. 25°S, Long 48°W) (Plankton, studies, in a mangrove region: Cananeia (Lat. 25°S, Long.48°W))

Canaeia is a lagoon region surrounded by mangrove vegetation consisting of Laguncularia racemosa and Rhizophora mangle. Investigations on the zooplankton and phytoplankton distribution, were carried out in the region, measurements of standing stock were made by means of cell-content and determination of chlorophyll, primary production was measured, and the suspended matter content was determined. The data obtained were correlated with the hydrographic and climatological parameters: tides, salinity, precipitation, temperature and dissolved oxygen.

The characteristic feature of the phytoplankton is the wide variety of species of which it is composed, although certain species predominate. The most important of these is skeletonema costatum, of which there are as many as 22,000,000 cells per litre during the summer season. Other common varieties are Asterionella japonica, Thalassionema nitzchioides, Biddulphia mobiliensis, Cyclotella stylorum and several species of Coscinodiscus.

At some places in the region, depending on the time of the year, microflagellates outnumber diatoms.

The part of phytoplankton measuring less than 50 microns, or nano-phytoplankton, is always predominant, regardless of whether it is calculated in terms of the number of cells or of the chlorophyll breakdown.

The maximum values obtained for chlorophyll were 60 mg/m^3, while measurements of primary production gave values of as much as 450 $mg/C/m^3/h$. Zooplankton rates amounted to a maximum of 220,000 individuals per cubic metre, copepods generally predominating. Salinity values always fluctuated widely and ranged from 3 per mille upstream in the rivers to 34 per mille at the river mouths. The water temperature differential between winter and summer may be as high as 8°. Tidal variations ranged from 0.20 m to 1.70 m.

Cananeia can be regarded as being a rather unstable region, with a high degree of eutrophication in summer as a result of rainfall and soil drainage.

LACHICA, F. de: Diversidad espacial y temporal de la bentocenosis del estuario del río Coatzacoalcos, Veracruz, México (Spatial and temporal benthocenosis variations in the estuary of the River Coatzacoalcos, Veracruz, Mexico)

Eight samples taken over a one-year period produced 40 species (27 fish and 13 invertebrates) represented by 12,183 specimens. The euryhaline marine component is the dominant feature of this community, and is followed in importance by the permanent estuarine community. There is a marked alternation of the two over the course of the year, owing to the hydrological characteristics of the estuary, which is limnetic for six months of the year.

The community has been chronically affected by the high levels of industrial and domestic pollution; its components have been depleted and the number of individuals has declined considerably. Spatial and temporal heterogeneity is calculated by means of the Shanon-Wiener index. Values of 2.67 bits per individual and per gram of biomass calculated at the station situated midway between the head of the estuary and the mouth are considered as being representative of benthocenosis fluctuations throughout the estuary, as well as during the annual sampling cycle. These are correlated with the hydroclimatic factors and with the presence of heavy metals in the sediment. Values of 0.82 bits per individual are found in the area where pollution is at its highest. Significant changes can be ascribed to the presence of masses of limnetic water which lower the diversity index, owing to the absence of euryhaline marine elements and the relative insignificance of freshwater species. The diversity values are raised by the presence of the marine component, but, although those elements play a significant role in the benthocenosis of the estuary, their penetration is greatly limited by pollution.

LESCURE, J.P.: La arquitectura del bosque de los manglares en la Guayana Francesa
(Mangrove forest architecture in French Guiana)

This paper discusses the mangrove forest in French Guiana. The author begins by referring to the distribution of the plant species to be found during the mangrove forest growth and maturation period, and stresses the pioneer role played by Laguncularia racemosa Gaernt. By contrast, Rhizophora mangle L. lives only on river banks or in salt water swamps situated behind the mangrove forest, where the only species that grows is Avicennia nitida Jacq. In the second part of his paper, the author follows up Oldeman's work and describes the morphogenesis and architectural models of the limited number of species encountered during the pioneering period of mangroves. He then goes on to analyse mangrove architecture in various selected specimen areas during the period when the trees are growing and maturing, and discusses the sylvogenesis of the mangrove. In the third part of his paper, he gives a short account of the relation between the bird population and the architectural pattern described.

LUGO, A.; CINTRON, G.; GOLENAGA, C.: El ecosistema del manglar bajo tensión
(Mangrove ecosystems under stress)

The responses of mangroves to natural or man-induced stresses are divided into five categories according to the point at which those stresses act on the ecosystem. It is suggested that, in humid environments, stresses of equal intensity and duration such as those created by isolating the mangroves by dykes, damming, canal training and the construction of roads or levees have a more serious impact on mangroves than fire, food-gathering or moderate grazing. The data available show that the response of mangroves to the first category of stresses is exponential or logorithmic, whereas the response to the second category is linear. The impact of other stresses is in intermediate categories of gravity. The susceptibility of mangroves to certain stresses varies with the type of forest involved.

Mangroves growing in arid climates are not as susceptible to disturbances in terrigenous factors as those in humid environments, where those factors make the ecosystem more dependent on runoff from the mainland. In arid environments, hypersensitivity is a natural stress whose effects are compounded by human action that reduces the water exchange rate. The response of mangroves to chronic exposure to petroleum in arid environments shows that the leaves are the ecosystem component which reveal the first signs of stress. Petroleum interferes with the gas exchanges of the roots and sediment, and this is reflected in the foliar component. Mangroves which do not benefit from the frequent renewal of water through tidal action suffer more from oil pollution than those subject to regular tidal flushing.

MIZRACHI, D.; PANNIER, F.; PANNIER, R.: Observaciones sobre la incidencia de lorantáceas semiparásitas en los manglares costeros venezolanos y sus posibles implicationes de dano ecológico al ecosistema (Observations on the occurrence of semi-parasite Loranthaceae in the coastal mangroves of Venezuela: the ecological damage they may do to the ecosystem)

The presence of higher semi-parasites of the Loranthaceae family on mangrove coasts and the physiology of their interaction with the host body have already been described (Pannier and Pannier, 1976).

Evaluation of the frequency of its appearance, the destruction it causes in the mangroves, propagation strategies and morphological and physiological studies carried out in the past all point to the possible epidemic nature of the invasion of the coastal mangroves of Venezuela by the species Struthanthus maritima Riz.

The paper also outlines a plan which would make it possible to characterize the epidemic in terms of physio-ecological and populational parameters and thereby evaluate the natural impact of its relationship to human intervention on the ecosystem and future drainage plans for controlling it.

MIZRACHI, D.; PANNIER, F.; PANNIER, R.: Estrategias del establecimiento de Conocarpus erectus L. en un manglar de franja de la costa venesolana (Strategies for the introduction of Conocarpus erectus L. in a belt mangrove on the coast of Venezuela)

Of all the non-viviparous mangrove species, Conocarpus erectus L., or the button mangrove, is that which has been studied least from the standpoint of its propagation strategies and its introduction as an arboreal component of the ecosystem.

The paper examines these strategies in terms of the influence exercised by natural and artifically varied environmental factors, such as light, temperature and salinity, on the germination and post-germination of the species. It was found that the salt content supplied by NaCl is a factor that reduces post-germination (implantation) but not germination, inasmuch as temperatures lower than 26°C inhibit germination compared with the optimum temperature recorded, which was 30°C.

Owing to the extreme sensitivity of this species to a high soil salt content, it is confined to areas of low salinity that are well drained and poor in nutrients. Two propagation strategies are accordingly encountered: the first, and predominant, strategy is vegetative, the other, sexual, which enables it to occupy and maintain its particular zone in the mangrove and also to spread.

MORAIS, J.O. de; SA FREIRE, G.S.; COUTINHO, P. da N.: Sedimentación de planicies intermareales de estuario del río Bacanga - Estado de Maranhao, Brasil (Sedimentation on intertidal flats in the River Bacanga estuary, Maranhao State, Brazil)

The estuary of the River Baranga is a tidal arm of the San Marcos bay on the north-eastern seaboard of Brazil. The estuary is divided into two parts by a dam located almost midway along it, and this gives rise to different areas of sediment deposition in the mangroves and tidal flats. The tidal range at this location is as much as 7 metres, and a pilot tidal power-station to harness the energy has been designed by Electrobras/Labomar.

On these flats, there are no sand-banks created by wave action on which a sedimentary layer could be deposited. The sediments are composed of silt and clay, and have been formed by hydrodynamic changes. The main component of the sediment is silt, which, together with clay, is carried down by the River Bacanga and spread far and wide by the tidal currents. The sediment facies encountered are as follows: silt, which is the most widespread; argillaceous silt; arenaceous silt; and sand. The sand is confined to the channel and the banks. Owing to the high organic-matter

content of the fine-grained sediments, the clay flats of the estuary are an ideal breeding-ground for a wide variety of molluscs and tropical burrowing bivalve fauna. The flats are drained by meandering streams which move laterally. The clay surface is lacking in primary structures, and there is only slight fluctuating wave action near the tidal limit.

OLIVEIRA, A.M.E. de: Distribución de los peces estuarinos en el noreste del Brasil, en relación a la salinidad (Distribution, in relation to salinity, of estuarine fish species in north-eastern Brazil)

The main purpose of this study was to compile data on the distribution of the fish species living in the estuaries of north-eastern Brazil, from Ceará to Sergipe (between 2° and 13° S), in relation to water salinity. The area in which the study was conducted has a large number of estuaries with a wide range of salinity gradients. An inventory was also compiled of the 156 fish species collected in the area, 142 of which were examined in the course of the study.

On the basis of the data compiled and information drawn from bibliographical sources, the ichthyofaunistic components were divided into four categories according to their tolerance for salinity: fresh water, oligohaline water, marine stenohaline water and marine euryhaline water. The fresh water species, including a small number of salt-tolerant river fish, were found in water of low to medium salinity (0.0 to 15 per mille). There are 16 such species in all, representing approximately 11.3 per cent of the total number.

The oligohaline species, i.e., species which have marine affinities and are now confined to estuaries, and which can tolerate salinity rates ranging from rather less than the density of sea water to fresh water, comprise 7 species, or 5.0 per cent of the ichthyofauna. Although these oligohaline species tolerate fresh water, they live in areas that are periodically exposed to fluctuations in salinity. The stenohaline species consist of the well-known sea varieties which do not penetrate into estuaries with salinity rates of less than 25 per mille. There are 35 such species, accounting for approximately 24.7 per cent of the total ichthyofauna. Most of these species appear in the estuaries at irregular intervals and apparently have no estuarine requirements. The marine euryhaline species include fish that have been identified in areas ranging from the sea to estuaries with salinity contents of less than 25 per mille. This group is divided into several categories according to the lowest salinity rates which the fish are capable of tolerating. There are some marine euryhaline species that are capable of tolerating salinity rates below 0.5 per mille and even fresh water in some instances. This group comprises 83 species, representing roughly 58.5 per cent of the total ichthyofauna, and includes the most important species. The marine euryhaline species predominate even in cases where salinity rates are low.

The salinity of the water is related to the number of species. Marine species decline in number as salinity decreases, and the opposite happens in the case of fresh water species. On the other hand, the number of oligohaline species remains virtually stable at all salinity levels.

PALACIO, J.: Variación de los invertebrados de la raíz del mangle (Rhizophora mangle) en la Ciénaga Grande de Santa Marta (Variation of invertebrates in mangrove root formations (Rhizophora mangle) in the Ciénaga Grande de Santa Marta swamp)

This study was begun in 1976; it lists the invertebrates living in the roots and branches of Rhizophora mangle. Variations in the community in relation to salinity are noted, for the purpose of establishing ecological indicators for different conditions. The salinity levels were taken as the factor limiting the presence of organisms in the area. The most numerous groups are crustaceans and molluscs. Most of them are marine species that are capable of tolerating mixohaline or polyhaline water. There is a high density of euryhaline species. No organisms representative of limnetic water were found.

PANNIER, R.: Estructura y dinámica del ecosistema de manglares: un enfoque global de la problemática (Structure and dynamics of the mangrove ecosystem: a global approach to the problems)

In view of the conditions to which mangroves in areas of coastal development are exposed and the need for basic knowledge of the structure and functioning of the ecosystem, the paper sets out to give a dynamic description of the system, based on examples of its population, soil and production dynamics.

It describes specific cases of negative impacts on mangroves in Latin America, such as the deterioration of the sedimentation pattern, timber felling and pollution, with a view to encouraging the introduction of corrective measures.

PASCUAS, N.B. de: Características fitosociológicas de los manglares en el Parque Natural Tayrona (Phytosociological characteristics of the mangroves in the Tayrona Natural Park)

Data on the structure of the mangroves and the vegetation surrounding them were collected and are analysed in this paper, which also describes the physiognomical and floristic changes in the vegetation in accordance with findings concerning climatic and edaphic behaviour patterns. The entire study was conducted in the Tayrona Park, on the Atlantic coast of Colombia.

POLI, C.R.; SNIZEK, F.: La acuicultura de manglares en la Universidad Federal de Santa Catarina: Cultivo de Mugil curema C & V ("paratí") en tanques (Mangrove aquaculture at the Federal University of Santa Catarina: pond-breeding of Mugil curema C + V (parati))

The University, with the financial backing of the Federal Government's Fund for Studies and Projects (FINEP), is engaged in a project for breeding Mugil curema in semi-elevated ponds with a mud floor and walls, the average height of which is 1.80 m.

The first stage in the project is the installation of 5 hectares of ponds, to which water is supplied by tidal inflows; pumping facilities are operated by wind power and drainage is by gravity.

The initial stock is being built up from young fish caught in the estuaries; research on reproduction will be carried out in the laboratory.

The purpose of the research is to obtain detailed data on fattening times, the possibilities of reproduction and the operating costs of the proposed system. For this purpose, a variety of tests will be carried out with plankton-based food obtained by fertilizing the water with organic and chemical fertilizers and a combination of the two, and with fishmeal additives. Pigs will be reared alongside the fish-breeding pond.

If the research findings show the project to be economically feasible it will be possible to make use of the 150,000 hectares of mangroves on the Santa Catarina seaboard for both small-scale fishing and a fishing industry, and thereby promote the rational exploitation of the environment.

PEREZ, M.E.; VICTORIA, C.H.: Algunos aspectos de la comunidad asociada a las raíces sumergidas del mangle rojo en dos áreas del Caribe Colombiano (Aspects of the community associated with the submerged roots of the red mangrove in two areas of the Caribbean seaboard of Colombia)

Ninety species of macro-invertebrates from the taxa Annelida, Mollusca and Crustacea were collected in the submerged roots of the red mangrove (Rhizophora

mangle L.) in Cartagena Bay and the Ciénaga de los Vásquez swamp on the Caribbean seaboard of Colombia.

The fauna consists mainly of a limited number of euryhaline species displaying a high degree of tolerance, most of which are equipped with filters and grow to a larger size in areas of high salinity. In the greater part of the areas investigated, the fauna is uniform in type, apart from places where salinity is low or where there is much pollution. The species composition among the fauna of the Ciénaga de los Vásquez swamp and Cartagena Bay is similar, but the former is more closely related to that of the surrounding coral areas.

PRAHL, H. von: Importanci del manglar en la biología de los camarones peneidos (The importance of mangroves in the biology of Peneides shrimps)

The presence of a series of nutrients and physico-chemical factors has a specific influence on the migrations of the post-larval stages of Peneides shrimps towards estuarine areas. The first post-larval stages of Penaeus stylirostris possess the ability to feed on the wax in mangrove leaves and to convert it, through the action of the wax enzyme cerase, into phospholipids. The leaves from which the wax has been removed are rapidly colonized by yeasts and bacteria, which form a mucous surface film that is consumed by the more advanced post-larval stages. The young shrimps consume the mangrove leaves by crushing them, so that they can feed off the epiphyte flora covering the leaf.

The organic remains of the crushed leaves are carried away to the estuary channels where, through the metabolic action of degrading organisms, metallic nuclei are released into the environment and foster the proliferation of planktonic algae, which the shrimps subsequently consume.

The physico-chemical factors act as selective physiological barriers, making it possible for the shrimps to be specifically distributed in the estuary, and also influence the dissemination and active transportation of the dissolved nutrients.

QUIROS, H.; VERNETTE, G.: Los foraminíferos bentónicos en áreas de manglar y su relación con el ecosistema (Tierra Bomba - Cartagena - Colombia) (Benthonic foraminifera in mangrove areas and their relation to the ecosystem (Tierra Bomba - Cartagena - Colombia))

Samples of sediment were collected at Punta Arena (Tierra Bomba, Cartagena) in an area of Rhizophora mangle and Laguncularia racemosa, separated by expanses of Thalassia testudinum and Syringodium filiforme, for the purpose of identifying the typical relation between the mangrove ecosystem and the substratum, in particular with regard to benthonic foraminifera connected with reef environments.

Data are provided on the microflora and macroflora associated with the aerial roots of the mangrove.

The sedimentary substratum is of the coral type, in which the fine part, measuring less than 63 microns, is the most widely represented. The part measuring over 400 microns has a wide variety of foraminiferous fauna, chiefly composed of individuals from the Rotaliidae and Miliolidae families, in particular the species Ammonia convexa (Collins, 1958), which appears to be characteristic of this biotope.

QUIROZ, C.: Cultivo de langostinos en el Perú. Estado actual e incidencias en el ecosistema de manglares (Prawn-breeding in Peru: present situation and impact on the mangrove ecosystem)

The paper gives an account of the research carried out in the Departamento de Tumbes in northern Peru on the behaviour patterns of the post-larval stages of Penaeus vannamei and P. stylirostris in tidal marshlands and on the possibility of breeding them and reproducing them in captivity. It also points to the growing

interest being taken in the establishment of private hatcheries and the influence these could have on the conservation of the mangrove ecosystem. It notes that the Peruvian Government has taken protective measures.

ROJAS, R.: Diferencias estacionales en la productividad de un criadero natural de camarones peneidos del manglar de Guadalupe (Antillas Francesas) (Seasonal differences in the productivity of natural Peneides shrimp breeding-grounds in the mangrove areas of Guadeloupe, French West Indies)

In the course of six research projects carried out between 1976 and 1978, a number of observations were made on the biology of several species of young Peneides shrimps and especially the ability of mangrove areas to produce them, in particular Penaeus (Melicertus) aztecus subtilis Pérez-Farfante, 1967; P.(M.) duorarum notialis Pérez-Farfante, 1967, and P.(M.) brasiliensis Latreille, 1817, which are the three species most commonly found at all times of the year in Guadeloupe.

Data on the local distribution of the eleven Peneides species on the island are given, and then the results obtained at different periods of the year (between seasons, rainy season and summer) are compared in respect of three biological parameters, namely numbers, average sizes and sex ratios; it is shown that there are significant variations in these parameters, including an appreciable decline in stocks and a reduction in the activity of the young shrimp populations in natural breeding areas (mangroves) during the dry summer season.

Lastly, the results of the different investigations carried out in widely varying parts of the island are analysed, and the conclusion is reached that the young of commercially valuable species are always found in close relation to mangroves and particularly to the channels driven through the ecosystem, which form one of the best natural breeding-grounds for the island's shrimps.

SALAS, G. de las; HILDEBRAND, P. von: Esbozo de un plan de investigaciones para el ecosistema de manglar Ciénaga Grande - Canal del Dique, Colombia (Outline plan for research on the Ciénaga Grande - Canal del Dique mangrove ecosystem, Colombia)

The authors put forward an overall research plan for the mangrove ecosystem composed of the Ciénaga Grande swamp and the Canal del Dique, on the Caribbean coast of Colombia. The aims of the plan are:

1. to determine the importance of mangroves for the water-land ecotone and the nutritional cycle of each phase;

2. to evaluate the impact which prolonged exploitation has had on mangrove associations;

3. to devise an exploitation system that will prevent mangroves from being destroyed;

4. to compare the different existing types of industrial and small-scale exploitation from the ecological, economic and social points of view.

The research plan is divided into three stages; their specific objectives are stated and the methodology applied is described.

There is an outline of the proposed research stages. The two basic aspects covered are: (a) past exploitation and the present state of the ecosystem; and (b) its importance and functioning.

TORRES, J.H.: Contribución al conocimiento de plantas tanantes y colorantes que proliferan en Colombia (Contribution to the knowledge of tannin and dye plants commonly encountered in Colombia)

Approximately 152 species representing 146 genera which form 71 families have been studied. They have all been mentioned in the literature or are known to the population generally as being sources of tannic extracts or tanning agents and of pigments for dyestuffs.

The first section of the paper identifies 65 genera of tannin plants together with their respective species, each with the name of the author and the work in which they were described for the first time. It also gives the vernacular name or names, a short morphological description of the external features of the species, its origin and family, its distribution in location and elevation within the country and its uses throughout the world.

The second section analyses some 81 plant genera representing a large number of species which have been catalogued as being sources of pigments or dyestuffs. The same method of presentation is used as for the tannin plants. There are many drawings of the most outstanding plants with industrial uses. Each section concludes with a list of the species with the highest tannin or dye content. The appendix contains a botanical glossary which is useful for understanding some of the technical terms that could hardly be avoided. Indexes of both the scientific and the vernacular names of the species will also be published; they will be useful in identifying the species.

VILLALOBOS, C.R.: Recursos bióticos en lagunas costeras, manglares y áreas adyacentes de América Latina (Biotic resources in coastal lagoons, mangroves and adjacent areas in Latin America)

This project is being carried out under the auspices of the Organization of American States, the Costa Rican National Council of Scientific and Technological Research and the University of Costa Rica. Its purpose is to evaluate the climatological, chemical, physical and biological features of a mangrove area which is of importance for the fishing industry in the region.

The area studied (Bahía Ballena) is situated on the Nicoya peninsula, on the Pacific coast of Costa Rica (latitude 9°42'40"N). The bay is relatively small and is associated, in its northern section, with a tidal inlet and a mangrove area. The entire area is regarded as being an important natural breeding-ground for the post-larval stages of commercial fish species and also offers considerable potential for aquacultural activities in the future.

Information on the chemistry of the area includes data on the vertical oxygen and salinity distribution at the four stations involved in the study. Analyses are also being made of the seasonal variations of such nutrients as carbonates, phosphates, nitrates and silicates. The physical studies being conducted cover current patterns in the Bay and an analysis of the velocities in a complete inflow and outflow cycle in the tidal inlet. Other factors, such as temperature and effective light penetration, are also being analysed. The biological information comprises an inventory of the region's resources, an analysis of primary productivity and a description of the red tides. Three collateral studies are also being carried out: the first on the role played by the different mangrove species in providing the estuarine system with nutrient inputs (in the form of leaves, flowers, embryos and other elements); the second on the ecological effects of the isopod Sphaeroma destructor on the root systems of Rhizophora mangle; and the third on the experimental breeding of the oyster Crassostrea gigas.

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